A taxonomic revision of *Garcinia* L. (Clusiaceae) in Australia, including four new species from tropical Queensland

W.E. Cooper

Summary

Cooper, W.E. (2013). A taxonomic revision of *Garcinia* L. (Clusiaceae) in Australia, including four new species from tropical Queensland. ***Austrobaileya*** **9(1): 1–29.** The genus *Garcinia* is revised for Australia with nine native and three naturalized species included. *Garcinia jensenii* W.E.Cooper, *G. leggeae* W.E.Cooper, *G. russellii* W.E.Cooper and *G. zichii* W.E.Cooper are newly described and illustrated. All species are fully described, together with notes on habitat and distribution. A key to *Garcinia* species in Australia is provided.

Key Words: Clusiaceae, *Garcinia*, *Garcinia brassii*, *Garcinia dulcis*, *Garcinia gibbsiae*, *Garcinia jensenii*, *Garcinia leggeae*, *Garcinia livingstonei*, *Garcinia mangostana*, *Garcinia mestonii*, *Garcinia riparia*, *Garcinia russellii*, *Garcinia zichii*, *Garcinia warrenii*, *Garcinia xanthochymus*, Australia flora, Queensland flora, Northern Territory flora, new species, taxonomy, identification keys, rainforest, naturalised species

W.E. Cooper, Australian Tropical Herbarium, James Cook University, Cairns Campus, McGregor Road, Smithfield, Queensland 4878, Australia.

Introduction

Garcinia L. (Clusiaceae) is a pantropical genus of about 260 species (Stevens 2007) of mostly dioecious shrubs and medium sized trees found in Africa, Madagascar, Comoros, the Indian subcontinent (including Bangladesh, Bhutan, India & Sri Lanka), SE Asia (including Cambodia, China, India, Laos, Myanmar, Nepal, Thailand and Vietnam), Malesia (including Malaysia, Indonesia, the Philippines and New Guinea), Solomon Islands, Australia, New Caledonia, Fiji and South America. Species are restricted to various forms of rainforest between the lowlands and the highlands, the exception being *Garcinia amplexicaulis* Vieill. ex Pierre, which occurs in exposed areas and secondary regrowth thickets on degraded and mined areas in New Caledonia. Within Australia, 12 species (nine native, three naturalised) of *Garcinia* occur in Queensland's rainforests and gallery forests from the Torres Strait islands south to the Kirrama Range in the Wet Tropics bioregion, with one species (*G. warrenii*) on Melville Island in the Northern Territory where it occurs in monsoon vine forest. Seven species are endemic to Queensland.

Garcinia plants have been recorded as having white, cream or yellow exudate (Nazre 2006); whereas, some Australian species also have clear or slightly milky exudate. Bracts and glands are a feature of this genus and there are three different types on most species, all are insignificant in species delimitation (Nazre 2006). Fruits are baccate with a single ovule per carpel, a unique combination in *Clusioideae* and a single ovule per carpel is a synapomorphy for the genus (Sweeney 2008: 1298). However, two Australian species, *Garcinia gibbsiae* S.Moore and *G. russellii* W.E.Cooper produce dry berries and commonly contain up to 4 ovules per locule and therefore the presence of a single ovule per carpel is no longer a diagnostic feature for the genus.

The first record of *Garcinia* from Australia was of *G. mestonii* F.M.Bailey (as '*mestoni*') (Bailey 1889), followed quickly by *G. warrenii* F.Muell. (Mueller 1891). The last overall flora account of Australian *Garcinia* enumerated only three species (*G. cherryi* F.M.Bailey [Bailey 1902; subsequently transferred to *Ternstroemia* (Theaceae) as *T.*

Accepted for publication 9 September 2013

cherryi (F.M.Bailey) J.F.Bailey & C.T.White], *G. mestonii* and *G. warrenii*) (Bailey 1899). Additional species were added by Moore (1917) and White (1933, 1936) and names for Malesian taxa have been variously misapplied to some species; however, the genus has been little studied taxonomically in the intervening years to the present. Consequently, putatively undescribed species known only by phrase names have been recognised in the last twenty years and nine native species were listed for Australia by Cooper & Cooper (2004) and CHAH (2007).

Examination of both live populations of plants and herbarium material, coupled with preliminary phylogenetic analyses of a limited DNA sequence dataset indicate that four undescribed species occur in Australia. Previously, *Garcinia* species endemic to Australia have been named in honour of worthy recipients and this revision continues the tradition by honouring four people who have made valuable contributions to Queensland botany. *G. jensenii* W.E.Cooper is described for material from Cape York Peninsula previously assigned to *G. riparia* A.C.Sm. at CNS. *G. leggeae* W.E.Cooper is described for all of the CNS and some of the BRI material of *G.* sp. (Claudie River) (the remaining BRI material is *G. jensenii*). *G. zichii* W.E.Cooper is described for specimens known as *G.* sp. (Davies Creek) and *G. russellii* had not been recognised by any herbaria but was listed in Cooper & Cooper (2004) as *G.* sp. (Mossman).

Lineages, clades and associated morphology

A phylogenetic analysis of DNA sequence data resolved two major lineages within *Garcinia* (Sweeney 2008). Australia is represented by 12 species (nine native and three naturalised) distributed among 6 clades. Two species occur in Clades 1 & 2 within Lineage A, and ten species occur in Clades 4, 5, 6 & 9 within Lineage B. Lineage A is distinguished by the presence of floral nectaries. Lineage B is distinguished in part, by the lack of disks, appendages and rings (nectaries) (Sweeney 2010: 158).

Sweeney (2008: 1299) in reference to Lineage B, stated that Clades 2 and 4 usually lack a well-developed pistillode. However, using Sweeney's evidence (2008: 1292 and *in litt.*), Clade 2 is part of Lineage A and Clade 4 does have a well-developed pistillode. It is Clade 7 and some species within Clades 5 and 9, which lack a well-developed pistillode.

Clade 1 (*Garcinia dulcis* (Roxb.) Kurz and *G. xanthochymus* Hook.f. [the latter naturalised in Queensland]) is distinguished by 5-merous flowers. Clade 2 (*G. livingstonei* [naturalised in Queensland]) is distinguished by free stamens. Clade 4 (*G. jensenii* and *G. zichii*) is distinguished by fleshy bilocular flowers and fruit, which are capped with a disk-like stigma, unlike the woody pericarp described by Sweeney (2008). Clade 5 (*G.mestonii* and *G. leggeae*) is distinguished by an androecium of fused filaments creating a solitary fleshy receptacle that is not adnate to the petals. Sweeney (2008) stated an additional possible synapomorphy for Clade 5 was the fruit, which usually have furrows along the septal radii, and for Clade 9, the presence of a distinctive adaxial, exudate-containing canal pattern in the leaves, consisting of highly branched, anastomosing canals. In Australian material; however, these characters poorly predict clade membership because furrows (or at least grooves) along the septal radii (putatively synapomorphic for Clade 5) occur in two species from Clade 9 but not in the Clade 5 species. Furthermore, intricately branched exudate-containing canals (putatively synapomorphic for Clade 9: *G. brassii* C.T.White, *G. gibbsiae*, *G. russelli* and *G. warrenii*) are found in *G. dulcis* and *G. livingstonei* (Clades 1 & 2). Clade 6 (*G. mangostana* L.) has no clear morphological synamorphies but is usually distinguished by a fungiform pistillode surrounded by an undivided 4-lobed androecium (Sweeney 2008). Clade 9 in Australian plants is distinguished by an androecium that is adnate to the petals.

Materials and methods

The study is based upon the examination of 521 specimens or photos from BRI, CANB, CNS, K, MEL, NSW and P. All specimens cited have been seen by the author and all native species have been observed in the field. Naturalised species have been seen in the field and/or cultivation.

Measurements of the floral parts and fruits are based on material preserved in 70% ethanol as well as fresh material from the field; d.b.h. refers to the forestry logging term of diameter at breast height. Abbreviations in the specimen citations are: EP (Experimental Plot), FR (Forest Reserve), LA (Logging Area), NP (National Park), SF/SFR (State Forest/State Forest Reserve) and TR (Timber Reserve). The superscript [1] refers to online images of specimens.

Species are arranged sequentially following the disposition of taxa outlined by Sweeney (2008).

Taxonomy

Garcinia L. *Sp. Pl.* 1: 443 (1753). **Type species:** *G. mangostana* L.

Rheedia L., *Sp. Pl.* 1193 (1753). **Type species:** *Rheedia laterifolia* L. [=*Garcinia humilis* (Vahl) C.D.Adams].

Cambogia L., *Gen. Pl.*, ed. 5:225 (1754). **Type species:** *Cambogia gummi-gutta* L. [=*Garcinia gummi-gutta* (L.) N.Robson].

Oxycarpus Lour., *Fl. Cochinch.* 647 (1790). **Type species:** *Oxycarpus cochinchinensis* Lour. [=*Garcinia cochinchinensis* (Lour) Choisy].

Verticillaria Ruiz & Pav., *Fl. Peruv. Prodr.* 81: t. 15. (1794). **Type species:** *Verticillaria acuminata* Ruiz & Pav.

Xanthochymus Roxb., *Pl. Coromandel* 2: 51 (1798). **Type species:** *Xanthochymus pictorius* Roxb. [=*Garcinia xanthochymus* Hook.f.].

Brindonia Thouars, *Dict. Sci. Nat.* 5: 339 (1804). **Type species:** *Brindonia indica* Thouars. [=*Garcinia indica* (Thouars) Choisy].

Stalagmitis Murray, *Commentat. Soc. Regiae Sci. Gott.* 9: 173 (1789). **Type species:** *Stalagmitis cambogioides* Murray [=*Garcinia ovalifolia* Oliv.].

Hebradendron Graham, *Companion Bot. Mag.* 2: 199 (1837). **Type species:** *Hebradendron cambogioides* Graham [=*Garcinia morella* Desr.].

Discostigma Hassk., *Flora* 25(2, *Beibl.*): 33 (1842). **Type species:** *Discostigma rostrata* Hassk. [=*Garcinia rostratum* (Hassk.) Hook.f.].

Rhinostigma Miq., *Fl. Ned. Ind., Eerste. Bijv.* 3: 495 (1861). **Type species:** *Rhinostigma parvifolia* Miq. [=*Garcinia parvifolia* Miq.].

Pentaphalangium Warb., *Bot. Jahrb. Syst.* 13: 382 (1891). **Type species:** *Pentaphlangium crassinerve* Warb. [=*Garcinia crassinervis* (Warb.) Kosterm.].

***Garcinia* in Australia:** Dioecious or monoecious (agamospermous in the naturalised *G. mangostana*), mostly subcanopy trees but also shrubs or canopy trees to 30 m; exudate, yellow, white or colourless, opaque or translucent. Branchlets square, ribbed or terete; petioles mostly channelled and ligulate. Interpetiolar gland-like bracts at nodes on stems and inflorescences, deltoid, peltate, tiny, caducous, brown. **Leaves** simple, opposite or rarely whorled, coriaceous or chartaceous, shape variable, glabrous; margin entire (or crenate in the naturalised *G. livingstonei*), mostly recurved; venation brochidodromous or paxillate; primary vein raised or flush; exudate-containing canals as parallel or random lines, branched or unbranched, continuous or broken dashes and dots. Inflorescences terminal, axillary or ramiflorous; bracts opposite, leaf-like with a primary vein, occurring at peduncle apex on racemose or paniculate species. Bracteoles mostly opposite, convex or cupular, occurring at pedicel base on most species. Flowers solitary or in cymes, compact panicles, racemes or fascicles, up to 66-flowered; actinomorphic, hypogynous, unisexual, may be fragrant, sessile or pedicellate; sepals 4 or 5, free or joined; petals 4 or 5, free, convex, cupular, erect to almost explanate. **Male flowers:** androecium of fused stamens as phalanges, free stamens or fused filaments as a receptacle, pistillode may be present; anthers mostly bithecate, sessile or with a short filament. **Female flowers:** staminodal phalanges present or absent; ovary superior, 2–13-locular, 1–4 ovules per locule; stigma sessile or with a short style, discoid or lobed. **Fruit** a fleshy or dry berry, sometimes with seams or furrows along septal radii, 2–13-locular; seeds 1–13, 1–4 per locule; aril present in most species. Germination is hypogeal or epigeal.

***Etymology*:** The generic epithet *Garcinia* is named for the Dutch army doctor and naturalist Laurentius Garcin (1683–1751).

Key to *Garcinia* species in Australia

1 Stigma on flowers and fruit disk-like and entire **2**
1. Stigma on flowers and fruit rayed, lobed or crenate **4**

2 Leaves always opposite; flowers with stamens united as phalanges and surrounding a fungiform pistillode; fruit red or blackish **3**
2. Leaves mostly 3-whorled (occasionally opposite or 4-whorled); flowers with free stamens, pistillode absent; fruit yellow to orange . . . . . . **3. *G. livingstonei**

3 Fruit much longer than wide, occurs in the Wet Tropics area . . . . **5. G. zichii**
3. Fruit equidimensional, occurs north from the McIlwraith Range . . . . **4. G. jensenii**

4 Seeds and ovules usually more than one per locule **5**
4. Seeds and ovules only one per locule. **6**

5 Leaves peltate . . . . **11. G. russellii**
5. Leaves never peltate. . . . . **10. G. gibbsiae**

6 Exudate in stems and leaves white; petals 5 . . . . **7**
6. Exudate in stems and leaves yellow; petals 4. . . . . **8**

7 Secondary veins 20–25 pairs . . . . **2. *G. xanthochymus**
7. Secondary veins 9–14 pairs . . . . **1. G. dulcis**

8 Leaves with 10 pairs of secondary veins; exudate-containing canals as short streaks, dashes and dots, unbranched . . . . **7. G. mestonii**
8. Leaves with 12 or more pairs of secondary veins; exudate-containing canals as continuous long lines. **9**

9 Leaves with 2 distinct intramarginal veins . . . . **8. *G. mangostana**
9. Leaves with 1 intramarginal vein or intramarginal vein absent or not obvious **10**

10 Leaves almost membranous; petals up to 3 mm long. . . . . **6. G. leggeae**
10. Leaves coriaceous; petals 5 mm or more long **11**

11 Leaves with tertiary veins absent . . . . **9. G. brassii**
11. Leaves with tertiary veins present **12**

12 At least some or most tertiary veins diminishing and not anastomosing . . . . **9. G. brassii**
12. All tertiary veins anastomosing. . . . . **12. G. warrenii**

1. Garcinia dulcis (Roxb.) Kurz, *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 43: 88 (1874); *Xanthochymus dulcis* Roxb., *Pl. Coromandel* 3: 66 (1820). **Type:** "ex Molucca Islands, cult. In Indian Botanic Garden, Calcutta" *n.v.*; *fide* Maheshwari (1964: 116).

***Illustrations*:** Hooker (1831: t. 3088); Wight (1840: 1: t. 192); van Nooten (1880: t. 15); Christophel & Hyland (1993: 81); Cooper & Cooper (2004: 123); CANBR (2010); Hyland *et al.* (2010); Sompong (2007: 248–250).

Tree to 20 m, dioecious; exudate white in stems and petioles, yellow in fruit; bark with fine vertical fissures, becoming thin flakey on older trees; branchlets square, ribbed, pendulous, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 10–30 mm long, channelled, ligulate; lamina elliptic, ovate or oblong-ovate, 75–280 mm long, 32–180 mm wide; base attenuate, cuneate, obtuse, cordate or asymmetrical; apex shortly acuminate, acute or obtuse; margin recurved; venation brochidodromous, primary vein ± flush on upper surface and protruding on abaxial surface; secondary veins 9–14 pairs, raised on both sides in dried specimens, angle of divergence from primary vein 30–60°, forming loops within 1.5–5 mm from margin; exudate-containing canals on upper side are numerous many-branched wriggly lines running more or less parallel to secondary veins, on the underside they are numerous parallel branched or unbranched lines which run at angles between being parallel to primary vein and margin, sometimes running parallel to secondary veins. **Male and female inflorescences** similar, axillary or ramiflorous, a raceme or a fascicle on a pulvinus, 1–many-flowered; bracteoles persistent, clustered at base of pedicels, ovate, convex, keeled, 1–2.25 mm long, 1–2 mm wide, base truncate, apex obtuse or acute, entire, minutely hairy especially around margin, sparsely hairy abaxially. **Male flowers:** fragrant, diameter 11–12 mm, glabrous; pedicels 7–14 mm long; sepals 5, free, orbicular, 2–4 mm long, 3–4 mm long, green, white or cream, margin minutely ciliate; petals 5, free, erect, imbricate, orbicular, convex, 5–7 mm long, 5–7 mm wide, membranous, green, lime-yellow, cream or yellow, glabrous, margin thin and minutely ciliate; androecium 5-phalangiate, glabrous; phalanges antepetalous, strap-shaped at base and flabellate towards apex, introrse, 8–9 mm long, 0.8–1.4 mm wide, apically branched into 5–10 filaments, filaments 0.3–0.7 mm long, 1 anther per filament; anthers bithecate, introrse, broadly-globose, *c.* 0.2 mm long and 0.3 mm wide; disk diameter *c.* 4 mm, pitted or honeycombed; pistillode rudimentary, conical-attenuate *c.* 0.5 mm long. **Female flowers:** fragrant, diameter 8–9 mm; pedicels 9–17 mm long; sepals 5, free, imbricate, orbicular, convex, 3–4.5 mm long, 4.5–6.5 mm wide, green or yellowish, glabrous, margin minutely ciliate; petals 5, free, imbricate, orbicular, convex, 7–8 mm long, 7–8 mm wide, green, cream or yellow, glabrous, margin minutely ciliate; staminodal phalanges 5, antepetalous, solitary and filament-like or 2 or 3-fused, distally inflexed, 2–3.5 mm long, 2 or 3–branched at apex, filaments 0.9–1.4 mm; antherodes 1–3 per phalange, introrse, bilobed, flattened, 0.2–0.3 mm long, *c.* 0.3 mm wide; nectaries alternating between phalanges, *c.* 2 mm long and 2 mm wide, pitted; disk *c.* 4 mm wide; ovary globular, *c.* 5 mm long and 4 mm wide, sessile, 5-locular, locules uniovulate; stigma 5-branched, style *c.* 1.8 mm long; stylar arms 5, *c.* 2.5 mm long. **Fruiting pedicel** *c.* 15 mm long, 5 sepals persistent at base; **fruit** a fleshy berry, ovoid, globular or depressed globular, apex often beaked, 35–50 mm long, 45–53 mm wide, yellow, glabrous; stigma 5-rayed, diameter 2–3 mm; seeds usually 5, *c.* 30 mm long and 20 mm wide; testa brown, smooth; aril fleshy, cream or yellow. *Claudie mangosteen*, *gourka*, *mundu tree*. **Fig. 1A & B, 2B.**

***Additional selected specimens (from 47 examined)*:** **Malaysia.** KELANTAN: Pasir Putih, Semarak Bt., Sep 1992, *FRI37081* (CNS). **Papua New Guinea.** WEST NEW BRITAIN DISTRICT: 32 km SW of Linga Linga Plantation, May 1973, *Isles & Katik NGF32248* (CNS). MILNE BAY PROVINCE: Esirava Creek, Tagula Island, Mar 1979, *Damas LAE74527* (CNS). **Australia. Queensland.** COOK DISTRICT: Banks Peak, Moa Island, Torres Strait, Jul 2008, *Fell 9722 & Stanton* (BRI); Moa (Banks) Peak, Moa Island, Torres Strait, Feb 1989, *Gray 4993* (CNS); Escarpment of Great Dividing Range, 14.6 km NE of Heathlands Ranger Base, Heathlands D & O Reserve, Oct 1993, *Fell 3746 & Stanton* (BRI); CSIRO Plot, West Claudie River, Dec 2011, *Cooper 2216 & Venables* (CNS); Gordon Creek, Oct 1972, *Hyland 6416* (CNS); Claudie River, Oct 1981, *Hyland 11181* (CNS); Iron Range, base of Lamond Hill, Sep 1988, *Sankowsky 861* (CNS); Nesbit River, Silver Plains Holding, Oct 1999, *Hyland 16253* (CNS); Nesbit River, Silver Plains Holding, Oct 1999, *Hyland 16254* (CNS); Junction of Leo Creek and Nesbit River, Aug 1993, *Fell 3385, Jensen & Barnes* (BRI); Chester River Scrub, Jun 1992, *Forster PIF10440 & Tucker* (BRI); TR 14, Leo Creek Road, Dec 1979, *Hyland 10132* (CNS); TR 14, Leo Creek Mine area, McIlwraith Range, Jun 1992, *Forster PIF10236, Tucker & Kenning* (BRI); Rocky River crossing, Oct 1996, *Cooper 1016 & Cooper* (CNS); Rocky River catchment,

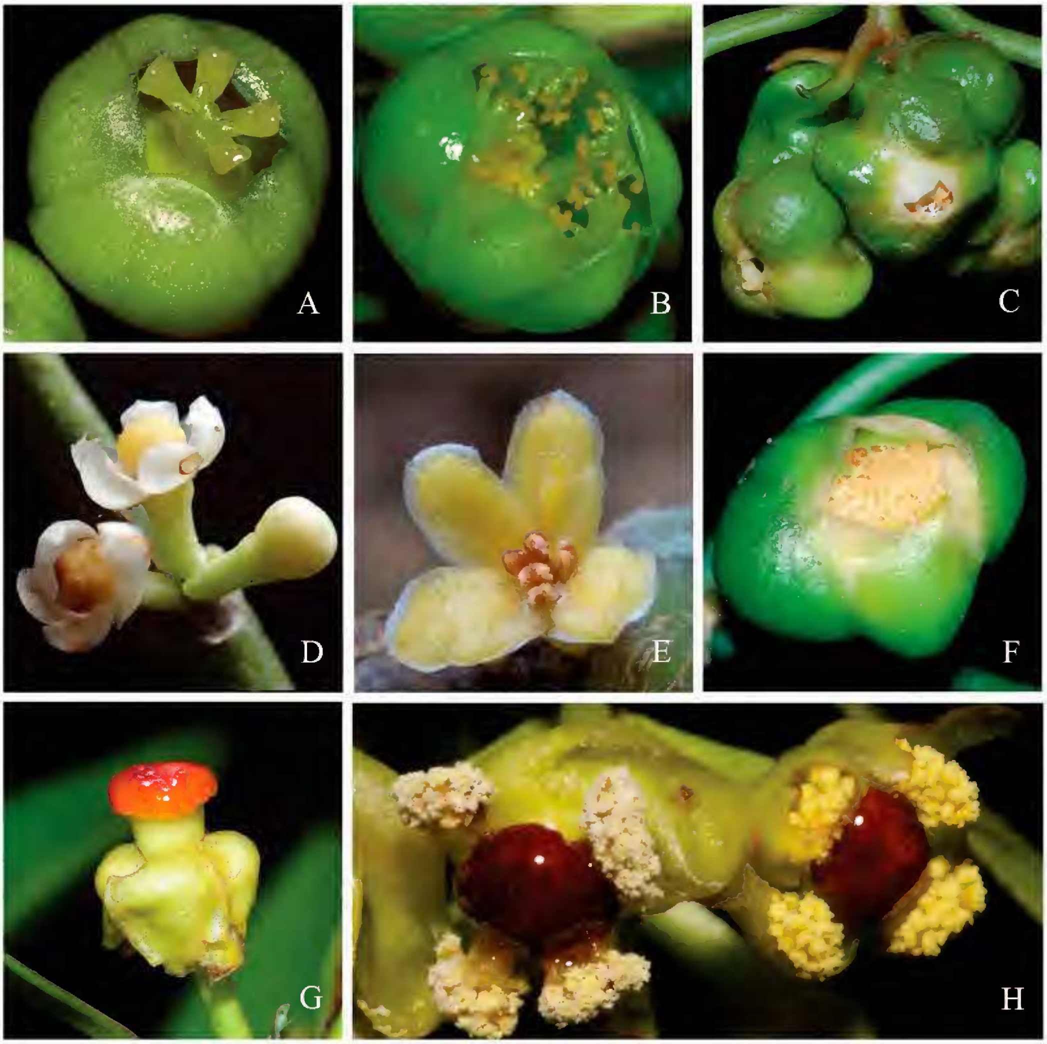


Fig. 1. Flowers. A. ***Garcinia dulcis*** ♀, showing rayed stigma at ovary apex (*Hyland 16253* [CNS]). B. ***G. dulcis*** ♂, showing apically branched phalanges (*Hyland 16254* [CNS]). C. ***G. mestonii*** ♂, showing small opening and anthers (*Sankowsky 2326* [BRI]). D. ***G. jensenii*** ♀, showing 3-flowered inflorescence and yellow stigma at apex of fungiform gynoecium (*Cooper 2225, Zdenek, Venables & Pritchard* [CNS]). E. ***G. leggeae*** ♂ showing anthers (*Cooper 2175, Jensen & Kemp* [CNS]). F. ***G. mestonii*** ♀, showing small opening and stigma (*Forster PIF24028* [CNS]). G. ***G. zichii*** ♀, showing viscous fungiform gynoecium (*Sankowsky 2547* [BRI]). H. ***G. zichii*** ♂, showing viscous fungiform pistillode and anthers at apices of 4-phalangiate androecium (*Dowe 1159* [CNS]). Photos: A, B, F, CSIRO; C, G, *G.Sankowsky*; D, *B.Venables*; E, *R.Jensen*; H, *J.Dowe*.

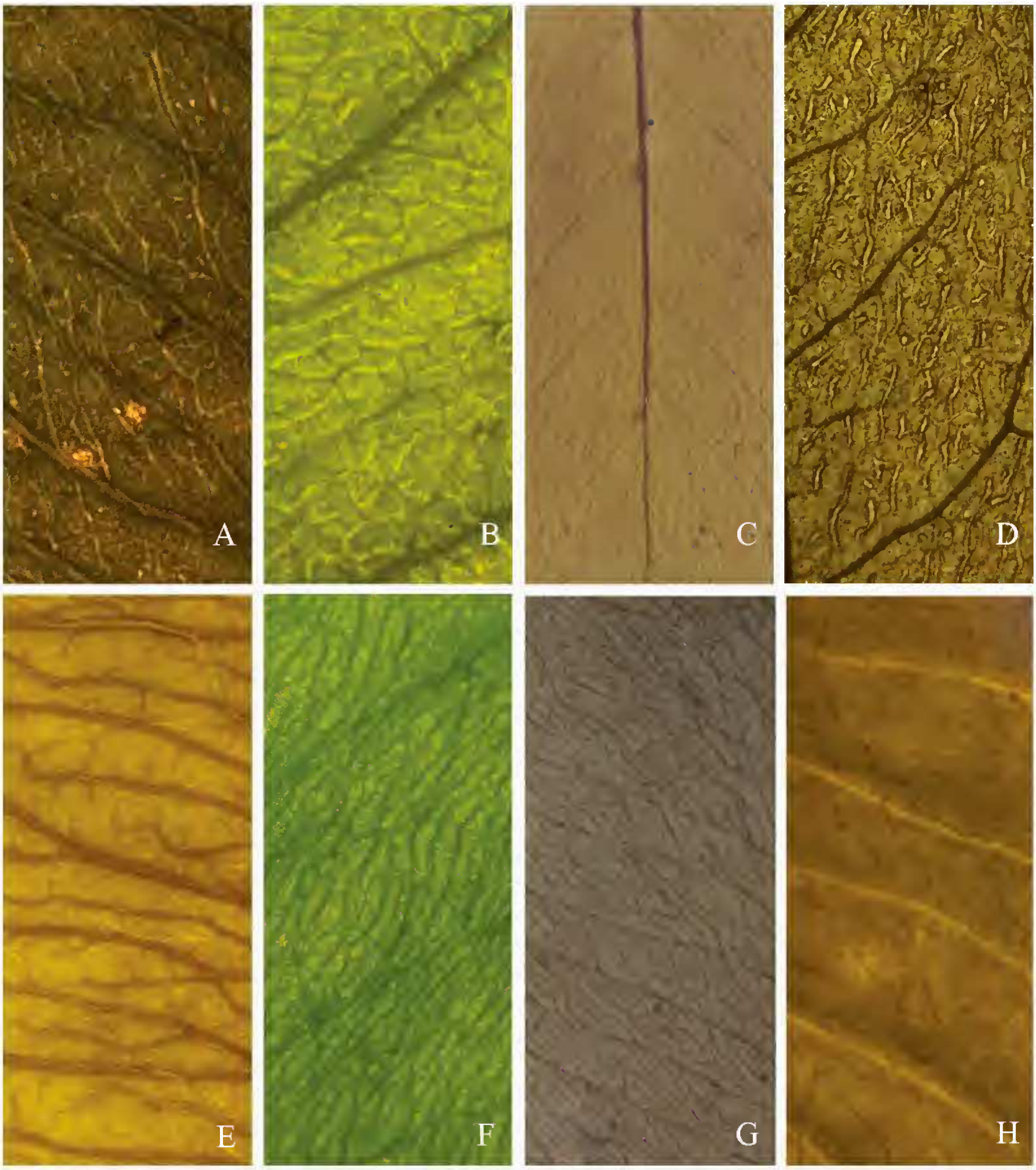


Fig. 2. Exudate-containing canals on leaf undersides shown crossing secondary venation. A. ***Garcinia brassii*** showing as pale lines (*Cooper 2163 & Ford* [CNS]). B. ***G. dulcis*** showing as pale lines and reticulations (*Cooper 2216 & Venables* [CNS]). C. ***G. jensenii*** showing as dark lines (*Cooper 2194, Jensen & Kemp* [CNS]). D. ***G. mestonii*** showing as pale wriggly dashes and dots (*Cooper 2203 & Jensen* [CNS]). E. ***G. gibbsiae*** showing as pale lines (*Cooper 2212* [CNS]). F. ***G. leggeae*** showing as dark lines (*Cooper 2187, Jensen & Kemp* [CNS]). G. ***G. warrenii*** showing as dark lines (*Cooper 474* [CNS]). H. ***G. livingstonei*** showing as dark lines (*Cooper 2218* [CNS]). Photos: A, B, C, D, E, G, H *W.Cooper*; F, *R.Jensen*.

Silver Plains, Aug 1997, *Cooper & Jensen 44* (CNS); Upper Massey (Massy) Creek, Oct 1962, *Smith 11719* (BRI); Melville Range 4 km N of Abbey Peak, Nov 1981, *Irvine 2195* (CNS).

***Distribution and habitat*:** *Garcinia dulcis* is widespread from Australia and New Guinea to South East Asia and India. Within Australia, it is restricted to north Queensland where it occurs in rainforest (complex, semideciduous notophyll and mesophyll vine forest) from the Melville Range on Cape York Peninsula to the Torres Strait islands, altitude 10–500 m (**Map 1**).

***Phenology*:** Flowers have been recorded from September to February; fruit has been recorded from August to October and January to March.

***Etymology*:** The specific epithet is derived from the Latin *dulcis* (sweet or pleasant) referring to the sour but palatable aril.

2. *Garcinia xanthochymus Hook.f. ex T.Anders., *Fl. Brit. India* 1: 269 (1874); *Xanthochymus pictorius* Roxb., *Pl. Coromandel* 2: 51, t. 196 (1805); *Stalagmitis pictoria* (Roxb.) G.Don., *Gen. Syst.* 1: 620 (1831); *Xanthochymus tinctorius* DC., *Prodr.* 1: 562 (1824) [*sphalm.* for *pictorius*]; *Garcinia tinctoria* (DC.) W.F.Wight, *Bull. Bur. Pl. Industr. U.S.D.A.* 137: 50 (1909). **Type:** India: Circars, *s.dat.*, *Roxburgh s.n.* (holo: BR, herb. Mart.).

***Illustrations*:** Roxburgh (1805, 2: t. 196) as *Xanthochymus pictorius* Roxb.; Kirtikar & Basu (1918, 1: t. 104); Sweeney (2008: 1289, K; 2010: 158, 160, 162); Sharma *et al.* (2012: 8, 9).

Shrub or tree to 20 m, dioecious; exudate yellow or milky; bark dark brown, with short vertical fissures, flaky on older trees; branchlets square, mostly pendulous, twigs distinctly 6–8-ribbed. **Leaves** discolorous, coriaceous, glabrous, shiny; petioles 10–25 mm long, ligulate; lamina oblong, linear-oblong, oblong-lanceolate, oblong-ovate or ovate, 120–410 mm long, 38–120 mm wide, base cuneate or rounded; apex acute, acuminate or apiculate; margin recurved; venation brochidodromous, primary vein slightly raised on upper side and distinctly raised on underside; secondary veins 20–25 pairs raised on both sides, angle of divergence from primary vein 50–60°, forming loops within margin, intramarginal vein 0.5–5 mm from margin; exudate-containing canals sparse on the underside as faint long lines running at angles between parallel to the margin and the primary vein. **Male flowers:** not seen for Australian material, recorded as: diameter 15 mm, fascicles 4–8-flowered; sepals 5; petals 5, diameter *c.* 8 mm; androecium 5-phalangiate; phalanges strap-shaped at base and flabellate towards apex, inflexed, apically branched into 3–6 filaments; anthers 2-celled, introrse; nectaries in between phalanges. **Female inflorescences** axillary or ramiflorous, a reduced raceme, fascicle-like, 2–14-flowered. **Female flowers:** fragrance not recorded; diameter 10–12(–20) mm; pedicels (18–)24–36 mm long; sepals 5, free, suborbicular, convex, 3.5–4 mm long, 6–7 mm wide, green or whitish, glabrous, margin minutely ciliate; petals 5, free, orbicular, convex, erect, 7.5–8 mm long, 10–11 mm wide, white, cream or pale yellow, margin minutely ciliate; staminodal phalanges 5, antepetalous, solitary and slender or 3 or 4-fused and strap-shaped at base and flabellate towards apex, inflexed, *c.* 3 mm long, branched into 3 or 4 filaments at apex, filaments 0.5–0.7 mm long, antherodes solitary or 3 or 4 per phalange, introrse, bilobed, flattened, *c.* 0.3 mm long and 0.5 mm wide; nectaries alternating between phalanges, *c.* 2 mm long and 2.5 mm wide, pitted; disk *c.* 5 mm wide; ovary globular, *c.* 4 mm long and 6 mm wide, sessile, 5-locular, locules uniovulate; stigma 5-branched, style *c.* 1.7 mm long; stylar arms 5, 2.5–3 mm long. **Fruiting pedicel** to 40 mm long, sepals persistent at base; **fruit** a fleshy berry, often asymmetrical with beak not centred, ovoid or globose, beaked, 38–65 mm long, 35–50 mm wide, yellow or orange; stigma 5-rayed, diameter 4–5 mm; seeds 1–5 (usually 1 or 2), 25–35 mm long, 15–18 mm wide, testa brown, veined; aril fleshy, yellow or orange. *sour mangosteen*, *false mangosteen*, *yellow mangosteen*, *gamboge tree*, *eggtree*.

***Additional selected specimens (from 6 examined)*:** **Australia. Queensland.** Cook District: Tributary of

Bushy Creek, Rumula, Oct 1998, *Holmes 66* (CNS); Cultivated, Cairns Botanic Gardens, Feb 2013, *Cooper 2217, Cooper & Venables* (CNS); Wadda Creek, East Palmerston, Sep 1941, *Wilson s.n.* (CNS); Patrick Road off Dunne Road, East Palmerston, Dec 2005, *Jensen 1486 & Cauley* (BRI); Tully, Dec 1945, *Shearer s.n.* (CNS). North Kennedy District: Delta, 3 miles [5 km] W of Bowen, Nov 1971, *Wright s.n.* (BRI [AQ313]). Moreton District: Rosemount Road, Nambour, Nov 1989, *Bruford s.n.* (BRI [AQ458316]).

***Distribution and habitat*:** *Garcinia xanthochymus* is a native of Bangladesh, Bhutan, Cambodia, China, India, Laos, Myanmar, Nepal, Thailand and Vietnam. It is cultivated for its edible sour fruit and has become naturalised in a few locations in Queensland from the Rumula area south to Nambour (**Map 6**), altitude 20–500 m.

***Phenology*:** Flowers have been recorded from February to May. Fruit has been recorded from February to May, November and December.

***Typification*:** *Garcinia xanthochymus* was named by Anderson in Hooker's *Flora of British India* (1874); however, nomenclature for this species commenced nearly 70 years earlier when Roxburgh (1805) described *Xanthochymus pictorius* Roxb. (non *Garcinia pictoria* Roxb.). De Candolle (1824) did not help the situation by totally misprinting (or perhaps 'correcting') the epithet as *X. tinctorius* DC. (Maheshwari 1964; Singh 1993). Anderson (1874) interpreted de Candolle's (1824) account as a misspelling, so coined the new name *G. xanthochymus* with Roxburgh's *X. pictorius* and de Candolle's *X. tinctorius* both in synonymy.

Much later, D'Arcy (1980) overlooked the name *Garcinia pictoria* Roxb. and published the superfluous new combination *G. pictorius* (Roxb.) D'Arcy based on *Xanthochymus pictorius* Roxb.

Anderson (1874) did not unambiguously specify a type collection for *Garcinia xanthochymus*, but did list *X. pictorius* Roxb. and the misprinted *X. tinctorius* DC. in synonymy, together with references to other literature and one specimen in the Wallich Catalogue (no. 4837). Under the distribution notes for this species Anderson (1874) cited a single specimen collected by Roxburgh from the Circars. Maheshwari (1964) listed the type for *G. xanthochymus* as this Roxburgh collection (deposited in BR) and this interpretation appears to have been universally accepted by later authors (Kostermans 1980; Singh 1993).

***Notes*:** Sharma *et al.* (2012) suggested that *G. xanthochymus* produces bisexual flowers; however they concluded that functional bisexuality had not been confirmed. Agamospermy is known or suspected for ten *Garcinia* species (not including *G. xanthochymus*) (Richards 1990a). Separate male and female flowers have been observed and illustrated by Sweeney (2010).

***Etymology*:** The specific epithet is derived from the Greek *xanthos* (yellow) and *chymos* (sap); referring to the exudate.

3. *Garcinia livingstonei T.Anders., *Bot. J. Linn. Soc.* 9: 263 (1866). **Type:** cult. In hort. bot. Calcutta. ex Mozambique, "in rupibus schistosis prope flumen Zambesi", *s.dat.*, *Kirk s.n.* (holo: CAL); *fide* Robson (1960: 400).

***Illustrations*:** Sweeney (2008: 1289, Q).

Shrub or tree to 18 m, monoecious; exudate yellow or reddish; bark grey and rough with numerous vertical fissures; branches terete, arching. **Leaves** discolorous, opposite or 3–4-whorled, coriaceous, glabrous; petioles 2–7 mm long, channelled, ligulate; lamina oblong, elliptical or oblanceolate, 35–110 mm long, 20–55 mm wide; base cuneate, rounded or cordate; apex acute, rounded, emarginate or apiculate; margin crenate or entire, recurved; venation brochidodromous, primary vein raised in a groove adaxially and distinctly raised abaxially; secondary veins 9–15 pairs, pale yellow, raised on both surfaces, angle of divergence from primary vein 60–70°; intramarginal vein merges with margin; exudate-containing canals on upperside are numerous branched lines ± parallel to secondary veins, on the lower side they are branched lines running at angles between the primary vein and margin. **Male and female inflorescences:** similar, axillary or ramiflorous, a fascicle, 2–7-flowered; bracteoles ± quadrate or rhombic, slightly convex, 1–1.5 mm long, 1–1.5 mm wide, base truncate, apex acute, margin 3-toothed, glabrous. **Male flowers:** fragrant, diameter 8–10 mm; pedicels 6.5–8 mm long, softly muricate; sepals 4, 2-whorled, free, D-shaped, *c.* 1 mm long and 1.8 mm wide, green, margin entire; inner pair orbicular, convex, *c.* 2 mm long and 2.5 mm wide, green or yellowish-green, margin entire; petals 5, free, orbicular, reflexed, 4.5–5.5 mm long, 3.5–4.5 mm wide, membranous, green or greenish-yellow, glabrous; androecium a globose yellow disk with *c.* 30 free stamens radiating like needles in a pin cushion, disk sunken directly below each stamen, filaments 1.5–1.7 mm long; anthers bithecate, globose, diameter *c.* 0.3 mm; pistillode absent. **Female flowers:** fragrant, diameter *c.* 7 mm; pedicels 16–20 mm long, softly muricate; sepals 4, free, green; outer pair D-shaped, *c.* 1.2 mm long and 1.4 mm wide; inner pair ovate, *c.* 2.5 mm long and 2 mm wide, glabrous; petals 5, free, orbicular or obovoid, *c.* 8 mm long and 6 mm wide, green or greenish-yellow; disk oblate, yellow, with *c.* 26 free staminodes, diameter *c.* 3.5 mm, sunken directly below each staminode; staminodes *c.* 2 mm long; antherodes 1 per staminode, ± globose, bilobed, diameter *c.* 0.5 mm; ovary obovoid, *c.* 3 mm long and 3 mm wide, 2-locular, locules uniovulate; stigma domed, not rayed. **Fruiting pedicel:** not seen for Australian material, recorded as: at least as long as fruit, staminodes usually persistent at base, sepals absent at base; **fruit** (not seen for Australian material) a fleshy berry, globular or obovoid, 10–30 mm long, 10–30 mm wide, orange or reddish-orange; seeds 1 or 2, cylindrical, 8–20 mm long; aril fleshy, orange. *African mangosteen*, *lowveld mangosteen*, *imbe*. **Fig. 2H.**

***Additional selected specimens (from 54 examined)*:** **Senegal.** Ouassadou, Jan 1959, *Berhaut 4302* (P^{1}). **Mali.** Bankoumana, Nov 2005, *Birnbaum 920* (P^{1}); Tienfala (25 km E Bamako), Dec 1978 (P^{1}). **Cameroon.** SOUTHWEST PROVINCE: Mt Kupe, Feb 1986, *Thomas & McLeod 5480* (P^{1}). **Comoros.** Mayotte, Sohoa, May 1997, *Pascal 934* (P^{1}); Itsamia, Nov 1999, *Labat 3223 & Yahaya, Dloubeiri & Mindhiri* (P^{1}). **Kenya.** Sep 1957, *Verdcourt 1936* (P^{1}). **Tanzania.** 40 km west of Lindi, Sep 1934, *Schlieben 5402* (P^{1}); Zanzibar, Nov 1889, *Sacleux 886* (P^{1}); Pwani Coast Region, Matumbi Hills, Oct 1997, *Phillipson 4960, Sitoni & Kibure* (P^{1}). **Zimbabwe.** Urungwe District, Oct 1964, *Bingham 1370* (P^{1}). **Mozambique.** Gaza, Nov 1970, *Correia 2015* (P^{1}); Lugela-Mucuba, Namagoa, s.dat., *Faulkner Kew 77* (P^{1}). **Australia. Queensland.** COOK DISTRICT: Cooktown, Anzac Memorial Park, Sep 2008, *McKenna 267* (CNS); Helen St, Cooktown, May 2013, *Cooper 2218 & Cooper* (CNS); Trevethan Creek, Cooktown Development Road, May 1998, *Jago s.n. & Wannan* (CNS).

***Distribution and habitat*:** *Garcinia livingstonei* is a native of Africa with a widespread distribution, occurring on the mainland from West Africa (including Senegal, Mali, Nigeria and Cameroon) through to Somalia and East Africa (including Kenya and Tanzania) and south to Zimbabwe, Angola and South Africa; as well as the Comoros islands. In Australia it has been cultivated and a recent record (*Jago s.n. & Wannan* CNS) from Trevethan Creek near Cooktown indicates possible naturalization (**Map 1**).

***Phenology*:** Flowers from Australian material have been recorded in May and no fruiting records exist.

***Notes*:** Cultivated plants of *Garcinia livingstonei* in Cooktown, which had been poisoned, were sprouting vigorous suckers from the base of otherwise dead trees.

One tree at Cooktown (*Cooper 2218*) had both female and male flowers confirming that this species is monoecious.

***Etymology*:** The specific epithet is in honour of the explorer David Livingstone (1813–1873), who was amongst the first to collect this species.

4. Garcinia jensenii W.E.Cooper **sp. nov**. Similar to *Garcinia hunsteinii* Lauterb. but differs in the leaf apex (bluntly acute versus acuminate), secondary veins (7–10 pairs versus *c.* 50 pairs), and secondary vein angle (*c.* 45° versus *c.* 80°). **Typus:** Australia: Queensland. COOK DISTRICT: about 3 km N of 3-ways, Iron Range National Park, 29 July 2013, *W.Cooper 2225, C.Zdenek, B.Venables & J.Pritchard* (holo: CNS [2 sheets + spirit], iso: 13 sheets to be distributed to A, BRI, CANB, FRI, K, KEP, KL, MEL, MO, NSW, NY, SING, US).

Garcinia riparia auct. non A.C.Sm.; Hyland *et al.* (2003, 2010); CHAH (2007).

Garcinia sp. (Claudie River L.J.Brass 19658) in part; Jessup (2007: 54, 2010: 44).

***Illustrations*:** Christophel & Hyland (1993: 81) as *G. riparia* vel aff.; Hyland *et al.* (2003, 2010), CHAH (2007) as *G. riparia;* Zodiac Publications (undated), as *Garcinia* sp. Claudie River.

Tree to 15 m, dioecious; exudate white or colourless; dbh to 150 mm; bark slightly flakey with fine vertical fissures, lenticels horizontal and more prevalent on younger trees; branchlets square, young twigs narrowly 4-winged. **Leaves** discolorous, coriaceous, glabrous; petioles 5–7 mm long, channelled, ligulate; lamina narrowly to broadly elliptic, ovate-elliptic or obovate, 52–160 mm long, 20–72 mm wide; base cuneate, attenuate or decurrent; apex acute, retuse-acute or rounded-acute; margin entire; venation brochidodromous, primary vein on upperside flush or slightly raised, distinctly raised on underside; secondary veins 7–10 pairs, slightly raised on both surfaces, angle of divergence with primary vein *c.* 45º, forming intramarginal loops 0.4–1.4 mm from margin; exudate-containing canals numerous and conspicuous on the underside as unbranched lines ± parallel to each other and running at angles between primary vein and margin. **Male inflorescences** axillary, a fascicle or raceme, 5–many-flowered, rachis up to 3.5 mm long; bracts at pedicel bases broadly ovate, apex acute, base truncate, convex, *c.* 1.6 mm long and 1 mm wide, glabrous; bracteoles present or absent, part way along pedicels, solitary or paired, broadly ovate, convex, *c.* 1 mm long and 1 mm wide, glabrous. **Male flowers:** fragrance not recorded, diameter 7–8 mm; pedicels 4.5–12 mm long; sepals 4, 2-whorled, colour not recorded but probably white or green white like females, glabrous; outer pair joined, D-shaped, convex, may be keeled, *c.* 1.6 mm long and 1.8 mm wide; inner pair free, petal-like, orbicular, convex, *c.* 4 mm long and 3 mm wide; petals 4, free, imbricate, orbicular, convex, *c.* 4 mm long and 3–4 mm wide, membranous, colour not recorded but probably white like females, glabrous; androecium 4-phalangiate, glabrous; phalanges antepetalous, strap-shaped, slightly ribbed, erect or distally inflexed, *c.* 3.2 mm long and 2–3 mm wide, apex divided into 2–7 short filaments; anthers 15–30 per phalange, completely enveloping phalange apex, D-shaped, circular or irregular, margin lobed, erect or introrse, diameter 0.5–6 mm; pistillode fungiform, *c.* 3 mm long and 2 mm wide at apex, apex colour not recorded but probably yellow like females. **Female inflorescences** terminal or axillary, supra-axillary or ramiflorous, a solitary flower, fascicle or condensed raceme, 3–9-flowered; peduncles 1.2–2 mm long; bracteoles triangular, keeled, *c.* 1 mm long and 1 mm wide, entire, persistent. **Female flowers:** fragrance not detected, diameter 4.5–6.5 mm; pedicels 3.5–4.5 mm long; sepals 4, 2-whorled, D-shaped, convex, white or palest green, glabrous; outer pair joined, *c.* 1 mm long and 2 mm wide, coriaceous; inner pair free, petal-like, orbicular, convex, 1.2–2 mm long and 2–3 mm wide, membranous; petals 4, free, imbricate, orbicular, convex, *c.* 2 mm long, 2–3 mm wide, margin thin, white, glabrous; gynoecium fungiform, unlobed, glabrous; ovary obovoid and laterally compressed, *c.* 1.2 mm long and 1.8 mm wide, 2-locular, uniovulate; stigma disc-like, entire, diameter *c.* 2.5 mm, yellow, not viscous. **Fruiting pedicel** *c.* 5 mm long; 2 joined sepals persistent at base; **fruit** a fleshy berry, globose or ellipsoid-globose, 12.5–15.5 mm long, 11–16 mm wide, pink or reddish; stigma at apex, diameter 3–3.8 mm; seeds 1 or 2, *c.* 10 mm long and 5 mm wide; testa and aril not recorded. **Fig. 1D, 2C.**

***Additional selected specimens (from 23 examined)*:** **Australia. Queensland.** Cook District: Widul Island, 4 km west of Mabuyang Island Airfield, 73 km NNW of Horn Island Airfield, Apr 2009, *Fell 10037* (CNS); Ulu (Saddle Islet), 62 km NE of Horn Island Airfield, Torres Strait, Feb 2012, *Fell 10712* (CNS); Eet Hill Track, Moa Island, Torres Strait, May 1987, *Budworth 1185* (BRI); *c.* 2 km N of St Paul's community, Moa Island, 46 km NNE of Horn Island Airfield, Torres Strait, Nov 2007, *Fell 8955* (CNS); Mew River, Muddy Bay, Cape York, Jun 1994, *Forster PIF15300 & Tucker* (BRI); Lake Boronto – Newcastle Bay, Cape York Peninsula, Sep 1974, *Tracey 14349* (BRI); Between Lockerbie & Somerset, Feb 1980, *Hyland RFK3984* (CNS); Lockerbie Scrub, Sep 1974, *Tracey 14306* (BRI); 5.5 km NE of Moreton, Jun 1994, *Fell 4457 & Buck* (BRI); Olive River, N bank, Sep 1974, *Tracey14373* (BRI); Nelson Creek, Aug 2011, *Cooper 2145, Venables & Murphy* (CNS); Iron Range NP, southside of Pascoe River, Sep 2004, *Sankowsky 2517 & Sankowsky* (BRI); about 3 km N of 3-ways, Iron Range NP, Dec 2012, *Cooper 2194, Jensen & Kemp* (CNS); Iron Range, Jul 1923, *Brass 19658* (BRI); about 2.8 km

N of 3-ways Iron Range NP, Jun 2013, *Cooper 2219, Cooper & Venables* (CNS); Chester River, Jun 1977, *Hyland RFK3555* (CNS); TR 14, Leo Creek Mine area, McIlwraith Range, Jun 1992, *Forster PIF10160, Tucker & Kenning* (BRI); McIlwraith Range, E foothills, Rocky River, Oct 1969, *Webb 9345 & Tracey* (BRI).

***Distribution and habitat*:** *Garcinia jensenii* grows on red soils derived from a mixture of basic igneous rocks and ferrugineous sandstone. It is as an understory tree in rainforest (semideciduous notophyll/ mesophyll vine forest) from the Torres Strait islands and down the eastern side of Cape York Peninsula to the McIlwraith Range at altitudes between sea level and 500 m (**Map 2**).

Garcinia jensenii occurs in rainforest dominated by *Archidendron hirsutum* I.C.Nielsen, *Buchanania arborescens* (Blume) Blume, *Calamus caryotoides* A.Cunn. ex Mart., *Dillenia alata* (R.Br. ex DC.) Martelli, *Euonymus australiana* F.Muell., *Hydriastele costata* F.M.Bailey, *Maranthes corymbosa* Blume, *Planchonella xylocarpa* C.T.White, *Ptychosperma elegans* (R.Br.) Blume, *Syzygium bamagense* B.Hyland & *Syzygium pseudofastigiatum* B.Hyland.

***Phenology*:** Flowers have been recorded in July and August; fruits have been recorded in December and February.

***Affinities*:** Within Australia, *Garcinia jensenii* is most similar to *G. zichii* W.E.Cooper. Both species have similarly shaped leaves and exudate canal pattern, a 2-locular ovary and 1 or 2-seeded fruit. *G. jensenii* has leaves with 7–10 pairs of secondary veins, flowers with white petals and fruit that are globose or ellipsoid-globose. *G. zichii* has leaves with 12–18 pairs of secondary veins, flowers with green or yellow petals and fruit that are distinctly ellipsoid.

***Notes*:** In Queensland, *Garcinia jensenii* has been confused with *G. riparia* that is considered to be endemic to New Guinea; however, the two species are significantly different morphologically. *G. jensenii* has white or colourless exudate, flowers pedicellate, ovary 1 or 2-locular, fruit not ribbed and 1 or 2-seeded. *G. riparia* has yellow exudate, flowers sessile with a 7–10-locular ovary, fruit ribbed and many-seeded.

***Etymology*:** The specific epithet honours botanist Rigel Jensen (1959–) acknowledging his contribution to botany in Australian and New Guinea, as well as his enthusiastic assistance with all of my botanical projects.

5. Garcinia zichii W.E.Cooper **sp. nov.** Similar to *Garcinia hunsteinii* but differs in the leaf apex (acute versus acuminate), lateral veins (7–10 pairs versus *c.* 50 pairs), lateral vein angle (*c.* 45° versus *c.* 80°) and the fruit shape (ellipsoid versus globose). **Typus:** Australia: Queensland. North Kennedy District: Tully Falls National Park, 2.2 km along Tully Falls Road from Charmillan Creek bridge, 8 November 2011, *A. Ford 5908 & M. Torello-Raventos* (holo: CNS [2 sheets + spirit], iso: 10 sheets to be distributed to BRI, CANB, K, KL, L, MEL, MO, NSW, SING).

Garcinia sp. aff. *G. hunsteinii*; Hyland (1982); http://www.anbg.gov.au/cgi-bin/apni Accessed January 2013.

Garcinia sp. (Davies Creek JGT 14745); Hyland *et al.* (2003).

Garcinia sp. (Davies Creek); Cooper & Cooper (2004: 124).

Garcinia sp. (Davies Creek J.G.Tracey 14745); Jessup (2007: 49, 2010: 44).

Garcinia sp. Davies Creek (J.G.Tracey 14745); CHAH (2007); Hyland *et al.* (2010).

Garcinia sp. (=AFO/1268); http://www.anbg.gov.au/cgi-bin/apni Accessed January 2013.

***Illustrations*:** Christophel & Hyland (1993: 81) as *G.* sp. aff. *G. hunsteinii*; Hyland *et al.* (2003) as *G.* sp. (Davies Creek JGT 14745); Cooper & Cooper (2004: 124) as *G.* sp. (Davies Creek); Hyland *et al.* (2010), as *G.* sp. Davies Creek (J.G.Tracey 14745).

Small tree or canopy tree to 30 m, dioecious; exudate colourless, white or slightly milky, meager; dbh to 20 cm, may have small buttresses; bark rough, fissured, slightly flaky, lenticels pale orange; branchlets square, deeply grooved between last 2 pairs of leaves, becoming terete. **Leaves** discolorous, coriaceous, glabrous; petioles 5–10 mm long, channelled, ligulate; lamina elliptical or rarely obovate, 35–110 mm long, 15–35 mm wide; base attenuate, cuneate or decurrent; apex bluntly acute; margin flat or may be recurved; venation brochidodromous, primary vein distinctly raised on upperside, slightly raised near base on underside and flush or slightly depressed towards apex; secondary veins obscure, 12–18 pairs, flush on both sides, angle of divergence with primary vein *c.* 60°, forming intramarginal loops *c.* 0.5 mm from margin; exudate-containing canals numerous and conspicuous on the underside as unbranched lines ± parallel to each other and running at angles between primary vein and margin. **Male inflorescences** axillary or rarely terminal, an umbel or rarely a cyme, 2–11-flowered (mostly 3–5-flowered), peduncles 0.8–2.5 mm long; bracts at peduncle bases and bracteoles at pedicel bases similar, triangular or broadly rhomboid, convex, keeled, 0.8–2.6 mm long, muricate, apex serrate with 3–7 teeth, caducous. **Male flowers:** not fragrant, diameter 7.5–8.5 mm, glabrous; pedicels 3.5–5 mm long; sepals 4, outer pair joined, inner pair free, imbricate, D-shaped, convex but not keeled, 2–4 mm long, 2–4 mm wide, coriaceous-membranous, yellow or green, glabrous, margin thin; petals 4, free, orbicular, convex, not keeled, becoming reflexed but remaining incurved at apex, 3–4.5 mm long, 3–4.5 mm wide, membranous, green; androecium 4-phalangiate; phalanges antepetalous, strap-shaped, ribbed, erect and becoming slightly reflexed, 1–4 mm long, 1–2 mm wide, apex undivided or divided into two short arms; anthers *c.* 20 per phalange, completely enveloping phalange apex, oblong, 0.8–1 mm long, *c.* 0.3 mm wide; pistillode fungiform, 2–2.5 mm long, 2–2.8 mm wide at apex, apex dark orange-red or reddish-brown and quickly becoming viscous once flowers are open. **Female inflorescences** axillary, an umbel, 3–5-flowered, peduncles 1–2 mm long; bracteoles triangular, *c.* 1.2 mm long and 1 mm wide, muricate, margin 3–5-toothed, caducous. **Female flowers:** occasionally fragrant, diameter 6–8 mm; pedicels 2–5 mm long; sepals 4, D-shaped or deltoid, convex, not keeled or slightly keeled, coriaceous-membranous, yellow or green, margin thin; outer pair joined, *c.* 2 mm long, 2–3 mm wide; inner pair free, 2–4 mm long, 2.5–4 mm wide; petals 4, free, imbricate, becoming reflexed, orbicular, convex, not keeled, 2.2–4.2 mm long, 2.8–4.2 mm wide, coriaceous-membranous, yellow or green, margin thin; gynoecium fungiform, glabrous; ovary ellipsoid, 0.6–1.5 mm long, 4–7 mm wide, 2-locular, uniovulate; stigma disc-like, entire, diameter 4–5 mm, yellow, orange, rusty red or brownish-red, quickly becomes viscous once flowers are open. **Fruiting pedicel** 2.5–5 mm long; sepals absent from base; **fruit** a fleshy berry, ellipsoid, 25–37 mm long, 10–18 mm wide, red to dark red or blackish; stigma at apex, diameter 4–6 mm; seeds one or two, surface slightly undulating, 22–32 mm long, 11–12 mm wide; testa brown; aril meagre, clear, gelatinous. *baconwood, marblewood.* **Fig. 1G & H.**

***Additional selected specimens (from 118 examined)*: Australia. Queensland.** Cook District: Cedar Bay NP, western slopes of Mt Finnigan, Oct 1999, *Forster PIF25016 & Booth* (BRI); Mt Hemmant just N of Noah Creek in Cape Tribulation area, Jul 1973, *Webb 11967 & Tracey* (BRI); Mt Windsor NP, Nov 2008, *Forster PIF34675, Jensen & McDonald* (BRI); Mt Misery, Jun 1992, *Forster PIF10759, Sankowsky & Tucker* (BRI); Pinnacle Rock Track, 4.5 km W of Karnak, Jun 1992, *Forster PIF10700, Sankowsky & Tucker* (BRI); TR 66, Mt Lewis, Jun 1997, *Forster PIF21239, Jensen & Tucker* (BRI); Mt Lewis Road, Aug 1957, *Smith 10094* (CANB); Davies Creek, SF 607, Aug/Sep 1971, *Tracey 14745* (BRI); SFR 607, Emerald LA, Aug 1982, *Gray 2701* (CNS); Mt Haig, Oct 2012, *Cooper 2147 & Ford* (CNS); Mt Haig, CSIRO plot E27, Oct 2012, *Cooper 2148 & Ford* (CNS); Lake Morris Road at start of track to tower 20, Sep 2012, *Dowe 1159* (CNS); Copperlode Dam, Cairns, Oct 1970, *Gittins 2196* (NSW); Palmerston Ridge Track, Wooroonooran NP, Feb 1995, *Hunter 1109* (BRI); Breeden property, Hughes Road, Topaz, Aug 1997, *Cooper 1152 & Cooper* (CNS); Track to Phoenix Battery, Towalla, Jul 1997, *Cooper 1132 & Cooper* (CNS); Elinjaa LA, Oct 1974, *Irvine 961* (CNS); Tully Falls NP, 2.2 km along Tully Falls road from Charmillan Creek bridge, Nov 2011, *Ford 5909 & Torello-Raventos* (CNS); SFR 344, Douglas Creek, 0.7 km along Carron Creek Road from Kirrama Road, Jun 2002, *Ford 3510 & Holmes* (CNS).

***Distribution and habitat*:** *Garcinia zichii* is endemic to the Wet Tropics bioregion of north-east Queensland from Mt Finnigan to the Kirrama Range (**Map 2**) at altitudes between 150–1300 m. It occurs in rainforest (evergreen simple to complex notophyll/

mesophyll vine forest) on soils derived from granite and rhyolite.

Garcinia zichii grows often in association with *Beilschmiedia oligandra* L.S.Sm., *Cryptocarya angulata* C.T.White, *Elaeocarpus elliffii* B.Hyland & Coode, *Flindersia pimenteliana* F.Muell., *Planchonella euphlebia* (F.Muell.) W.D.Francis, *Syzygium endophloium* B.Hyland & *S. wesa* B.Hyland.

***Phenology*:** Flowers have been recorded in October and November; fruits have been recorded from June to November.

***Affinities*:** Within Australia, *Garcinia zichii* is most similar to *G. jensenii*. Both species have similarly shaped leaves and exudate canal pattern, a 2-locular ovary and 1 or 2-seeded fruit. *G. zichii* has leaves with 12–18 pairs of secondary veins, flowers with green or yellow petals and fruit that are distinctly ellipsoid. *G. jensenii* has leaves with 7–10 pairs of secondary veins, flowers with white petals and fruit that are globose or ellipsoid-globose. *G. zichii* is also similar to *G. hunsteinii* Lauterb. from New Guinea. *G. zichii* has colourless, slightly milky or white latex, leaf apex bluntly acute and fruit much longer than wide, whereas *G. hunsteinii* has white or yellow latex, leaf apex acuminate and globose fruit.

***Notes*:** There is one specimen (*Cooper 1152*) as well as an observation by Tim Hawkes *pers. comm.*, of fruit dehiscing, which was presumably caused by recent abundant rainfall. This phenomenon is well documented within horticulture for other plant groups, occurring after superfluous moisture is applied to orchard plantings. The abundant water causes osmotic absorption through the epicarp and the disintegration of the cuticle (Opara *et al.* 1997: 227).

The exudate-containing canals within the leaves (a useful distinguishing character in Australian *Garcinia*) of this species are indistinguishable from *G. jensenii* (**Fig. 2C**).

***Etymology*:** The specific epithet honours Frank Zich (1968–), a most competent and obliging curator of the collection at the Australian Tropical Herbarium (CNS).

6. Garcinia leggeae W.E.Cooper **sp. nov.** Similar to *Garcinia riparia* but differs by flower diameter (5 mm versus 15 mm), stamen number (5–9 versus 40–50), fruit shape (ovoid versus obovoid, oblate or patelliform), fruit size (20–27 mm long and 29–45 wide versus *c.* 70 mm long and *c.* 50 mm wide), sepal size on fruit (*c.* 1.5 mm long versus *c.* 5 mm in *G. riparia*). **Typus:** Australia: Queensland. COOK DISTRICT: Gordon Creek, Iron Range National Park, 5 December 2012. *W.Cooper 2187, R.Jensen & J.Kemp* (holo: CNS [2 sheets + spirit], iso: 7 sheets to be distributed to BRI, CANB, K, KEP, L, MO, SING).

Garcinia sp. (Claudie River LJB 19658) in part; Hyland *et al.* (2003).

Garcinia sp. (Claudie River); Cooper & Cooper (2004: 123).

Garcinia riparia auct. non A.C.Sm.; Cooper & Cooper (2004: 123).

Garcinia sp. (Claudie River L.J.Brass 19658) in part; Jessup (2007: 54, 2010: 44).

Garcinia sp. Claudie River (L.J.Brass 19658) in part; CHAH (2007); Hyland *et al.* (2010).

***Illustrations*:** Christophel & Hyland (1993: 81) as *G. riparia* vel aff.; Cooper & Cooper (1994: 146–147) as *G. riparia vel. aff.*; Hyland *et al.* (2003) as *G.* sp. (Claudie River LJB 19658); Cooper & Cooper (2004: 123) as *G.* sp. (Claudie River) & as *G. riparia.*

Shrub or small tree to 6 m, dioecious; exudate yellow; dbh to 100 mm, often multi-stemmed; bark grey or greyish-brown, fissured and flakey, lenticels numerous; branchlets square, glabrous. **Leaves** discolorous, almost membranous, shiny on upperside and less so on underside, glabrous; petioles 5–8 mm long, channelled, not ligulate; lamina elliptical, 30–145 mm long, 25–57 mm wide, base cuneate; apex acuminate or caudate, rarely acute or obtuse; margin narrowly recurved; venation brochidodromous, primary vein flush on upperside and raised on underside; secondary veins 12–16 pairs, slightly raised on both surfaces, becoming puckered in dry specimens, angle of divergence from primary vein *c.* 45°, intramarginal vein 0.6–1.2 mm from margin; exudate-containing canals numerous, continuous parallel or intertwined lines running at angles between ± parallel to primary vein and diverging up to *c.* 45°. **Male inflorescences** axillary or ramiflorous, a fascicle seated on a pulvinus, 1–3-flowered; bracteoles persistent, triangular, *c.* 0.7 mm long and 0.8 mm wide, base truncated, apex acute, glabrous, margin entire. **Male flowers:** fragrant, diameter 5–6.5 mm, glabrous, sessile; sepals 4, 2-whorled, free, ovate, convex, entire, *c.* 1.5 mm long and 1 mm wide, membranous, green or yellowish, glabrous, margin thin; petals 4 (rarely 5), free, explanate, oblong-elliptic, sometimes slightly convex, 2.5–3 mm long, *c.* 1.5 mm wide, membranous, cream or yellow, margin entire or minutely ciliate; androecium a fleshy receptacle not adnate to petals, *c.* 0.5 mm long; anthers 5–9, sessile or almost sessile, erect or extrorse, quadrate, *c.* 0.4 mm long and 0.4 mm wide, bithecate; pistillode absent. **Female inflorescences** axillary or ramiflorus, a solitary flower, sessile; bracteoles persistent, triangular, convex, *c.* 0.8 mm long and 0.8 mm wide, base truncated, apex acute, glabrous, margin entire. **Female flowers:** fragrant, diameter *c.* 5 mm, sessile; sepals 4, 2-whorled, free, ovate, convex, 2–3 mm long, 1.5–2 mm wide, membranous, green or yellowish, glabrous, margin thin, entire; petals 4, free, spreading widely, oblong-elliptic, sometimes slightly convex, *c.* 3 mm long and 1.5 mm wide, membranous, cream or yellow, glabrous, margin entire and thin; staminodal phalanges 4, adnate to petals, filament-like with a globose apex, distally inflexed, *c.* 1.4 mm long; antherodes 1 per phalange, *c.* 0.8 mm long; ovary urceolate, *c.* 2.5 mm long and 1.5 mm wide, sessile, 6–13-locular, uniovulate; stigma sessile, diameter *c.* 1.5 mm. **Fruiting pedicel** 0.7–1 mm long, sepals persistent at base *c.* 1.5 mm long, **fruit** a fleshy berry, ovoid (oblate, patelliform or asymmetrical when some ovules infertile), 20–27 mm long, 29–45 mm wide, pink-red to dark red, 6–13 septum lines, 6–13 segments; seeds 6–13, hairy, *c.* 11 mm long and 7–8.5 mm wide (not including hairs); testa brown; aril fleshy, translucent whitish or pinkish. **Figs. 1E, 2F.**

***Additional selected specimens (from 22 examined)*:** **Queensland.** Cook District: Claudie River, Nov 1977, *Hyland RFK3623* (CNS); *ditto*, Jan 1982, *Hyland 11515* (CNS); *ditto*, Dec 1982, *Hyland 12412* (CNS); *ditto*, Dec 1982, *Hyland 12413* (CNS); West Claudie River, Iron Range, Aug 1997, *Jensen 874* (CNS); Iron Range, Sep 1962, *Volck AFO2600* (CNS); Iron Range NP, CSIRO EP/42, Sep 2008, *Ford 5422, Metcalfe, Murphy & Bradford* (CNS); Claudie River EP/42, July 1978, *Unwin 625* (CNS); Claudie River, Iron Range, May 1992, *Cooper 279 & Cooper* (CNS); Claudie River area, Oct 1968, *Webb 8335 & Tracey* (BRI); Claudie River, Iron Range NP, Dec 2012, *Cooper 2168, Jensen & Kemp* (CNS); Gordon Creek, Iron Range NP, Dec 2012, *Cooper 2171, 2175, 2177, 2186, 2188, Jensen & Kemp* (CNS); *ditto*, Jun 2014, *Cooper 2220 & Cooper* (CNS); Gordon Creek, 10 km ENE of Mt Tozer, Iron Range NP, May 1992, *Fell 2543* (BRI).

***Distribution and habitat*:** *Garcinia leggeae* is endemic to rainforest (evergreen mesophyll vine forest) in the Iron Range area, mostly on the Claudie River and Gordon Creek floodplains but occasionally on hillslopes to an altitude of 75 m (**Map 3**).

Garcinia leggeae grows as an understory shrub or small tree on alluvial soils derived from basalt, frequently under a canopy of *Blepharocarya involucrigera* F.Muell., *Calamus australis* Mart., *Garcinia dulcis*, *G. warrenii*, *Lasjia claudiensis* C.L.Gross & B.Hyland, *Myristica insipida* R.Br., *Nauclea orientalis* (L.) L., *Pandanus zea* H.St.John, *Syzygium bamagense* B.Hyland & *Tetrameles nudiflora* R.Br.

***Phenology*:** Flowers have been recorded in June and December; fruits have been recorded in May, August and September.

***Affinities*:** *Garcinia leggeae* is similar to *G. riparia* from New Guinea. Compared with *G. riparia*, *G. leggeae* is a more diminutive plant, having much smaller flowers (5 mm versus 15 mm) with fewer stamens (5–9 versus 40–50), smaller fruit (20–27 mm long and 29–45 wide versus *c.* 70 mm long and *c.* 50 mm wide) and smaller sepals on ripe fruit (*c.* 1.5 mm long versus *c.* 5 mm).

***Notes*:** Plants are frequently multi-stemmed, presumably caused by the forces of floodwater and floating debris during the wet season.

Some leaves on most herbarium collections, and all plants in the field seen by the author, are marked with black spots (diameter *c.* 5 mm), which appear to be caused by insects rather than fungi.

***Etymology*:** The specific epithet honours ornithologist and ecologist Sarah Legge (1969–) who collected this species as well as many other valuable specimens for illustration in the fruit book (Cooper & Cooper 2004), while working in the Iron Range area.

7. Garcinia mestonii F.M.Bailey, *Report on New Plants, Preliminary to General Report on Botanical Results on Meston's Expedition to the Bellenden-Ker Range* 2 (1889), as 'mestoni'. **Type:** Australia: Queensland. Cook District: Bellenden-Ker Range at an altitude of 2000 feet, [June 1889], [*A.Meston & D.Whelan s.n.*] (holo: BRI [AQ340247][1]).

***Illustrations*:** Christophel & Hyland (1993: 81); Cooper & Cooper (2004: 123), Hyland *et al.* (2010).

Shrub or small tree to 6 m, dioecious (rarely monoecious); exudate yellow, meagre; bark nondescript with irregular-shaped lenticels; branchlets square when young, becoming terete. **Leaves** discolorous, coriaceous, glabrous; petioles 6–11 mm long, channelled, not ligulate; lamina elliptic, ovate, lanceolate, obovate, oblanceolate, 35–80 mm long, 12–34 mm wide; base attenuate, cuneate or oblique; apex caudate or acuminate; margin may be recurved in dry specimens; venation brochidodromous, primary vein ± flush on upperside and raised on underside; secondary veins 10 pairs, angle *c.* 70° to primary vein, forming loops *c.* 1 mm from margin; exudate-containing canals numerous as short streaks, dashes and dots (more conspicuous on upperside), running at angles between 45° and parallel to primary vein or margin. **Male inflorescences** axillary, terminal or ramiflorous, a 2–5-flowered umbel or fascicle; bracts oblong, convex, 1.5–5.5 mm long, 0.5–0.8 mm wide, glabrous, apex obtuse, base truncate, caducous; bracteoles triangular, *c.* 0.8 mm long and 0.6 mm wide, caducous; peduncles absent or up to 4 mm long. **Male flowers:** not fragrant, diameter *c.* 4 mm; pedicels 1.5–2.5 mm long; sepals 4, 2-whorled, outer pair joined, D-shaped, cupular, *c.* 4 mm long and 4.5 mm wide, green, glabrous, margin thin; petals 4, orbicular, cupular with apex recurved, *c.* 4.8 mm long and 4.8 mm wide, membranous, green or cream, glabrous, margin thin; androecium a fleshy receptacle not adnate to petals, *c.* 2.5 mm long and 3.2 mm wide; anthers *c.* 16, triangular, sessile or almost sessile, 0.6–1 mm long, 0.6–1 mm wide at base, bithecate; pistillode absent. **Female inflorescences** axillary or terminal, solitary flowers or 2–3-flowered umbels or fascicles; bracts 4-whorled, oblong, 1.5–3.2 mm long, *c.* 1 mm wide, caducous; bracteoles triangular, *c.* 1 mm long and 0.6 mm wide; peduncle *c.* 1 mm long. **Female flowers:** not fragrant, pedicels *c.* 2.5 mm long, diameter 6–7.5 mm; sepals 4, 2-whorled, outer pair joined, inner pair free, D-shaped, cupular, 3.8–4.4 mm long, 4.3–5.5 mm wide, membranous, green or cream, glabrous; petals 4, free, orbicular, cupular with apex recurved, *c.* 5 mm long and 4 mm wide; staminodal phalanges adnate to petals, narrowly or broadly triangular, apically 2 or 3-branched, distally inflexed, *c.* 2 mm long, antherodes 2 per branch; ovary oblate, 2.2–2.8 mm long, 4–4.5 mm wide, sessile, 3–9-locular, uniovulate; style *c.* 0.5 mm long, stigma diameter *c.* 2.5 mm, 3–9-rayed. **Fruiting pedicel** 1–3 mm long; 4 sepals persistent at base; **fruit** a fleshy berry, depressed globular, 31–50 mm long, 40–60 mm wide, cream or greenish-cream; stigma 3–9-rayed, diameter 3.5–4 mm; seeds 13–25 mm long, *c.*10 mm wide, testa brown; aril fleshy, cream. *Meston's mangosteen.* **Fig. 1C & F, 2D.**

***Additional selected specimens (from 26 examined)*:** **Australia. Queensland.** Cook District: Little Cooper Creek, Cow Bay, Cape Tribulation area, Oct 1994, *Small s.n.* (CNS [QRS104526]); Behana Creek, S of Gordonvale, Jul 2005, *Halford Q8446 & Jensen* (BRI); Divide between Babinda Creek and East Mulgrave, May 2002, *Jago 6211* (CNS); Mt Harold, Aug 1985, *Irvine 2322, 2323* (BRI, CNS); Goldsborough Road, Mulgrave River Valley, Jul 1992, *Tucker s.n.* (CNS [QRS105577]); Goldsborough Road, Jul 1992, *Sankowsky 1332* (CNS); East Mulgrave River, Nov 1995, *Jensen 483* (CNS); Ridgeline NW of airplane wreck, Bellenden Ker, Jun 1995, *Hunter 5308* (BRI); Mt Bellenden Ker, *c.* 7/8 mile SE of centre peak, Jun 1969, *Smith 14691* (BRI); Harvey Creek, N of Bellenden Ker, Dec 1998, *Forster PIF24028* (CNS); Harvey Creek, Dec 2012, *Cooper 2203, 2204 &*

Jensen (CNS); Cultivated at Tolga, ex Harvey Creek, Dec 2003, *Sankowsky 2326 & Sankowsky* (BRI); Sankowsky's garden, Tolga [ex Harvey Creek], Jan 2013, *Cooper 2209, Sankowsky & Jensen* (CNS); NPR 226, Parish of Bellenden Ker, Dec 1983, *Hyland 25062 RFK* (BRI, CNS); Ridgetop S of Tower 6, Bellenden Ker, Jun 1995, *Hunter 5292* (BRI); E slopes of Bellenden Ker near Station 3 on the Bellenden Ker Cable Car Track, Jan 1981, *Irvine 2056* (BRI, CNS); Bellenden Ker, *s.dat.*, *Meston 1* (BRI [AQ166293]); Bellenden Ker Range, Mar 1922, *White s.n.* (BRI [AQ166291]); Bellenden Ker, below summit, Jun 1949, *Smith 4236* (BRI); Wooroonooran NP, headwaters of East Mulgrave River, 5 km W of Bellenden Ker township, Nov 2000, *Forster PIF26412, Booth & Jensen* (BRI).

Distribution and habitat*: *Garcinia mestonii is endemic to the Wet Tropics bioregion of north-east Queensland between Cape Tribulation and the Mt Bellenden Ker Range (**Map 3**). It occurs in rainforest (evergreen, simple/complex notophyll/mesophyll vine forest) on granitic and metamorphic soils at altitudes between 30 and 1340 m.

Phenology: Flowers have been recorded in December and January; fruit has been recorded from August to February.

Typification: The type collection at BRI has minimal original labelling attached to the sheet, apart from a tattered scrap of paper with the number 18 and the words 'Meston's Apple'. No specific collectors or date of collection are given; although a copy of the protologue is attached. In the protologue Bailey (1889) noted that it was collected by Messrs. Meston and Whelan on the first ascent of Bellenden Ker. As noted by Dowe & Broughton (2007) this was in June 1889.

Archibald Meston is well known as the leader and organiser on the 1899 and 1904 Bellenden Ker expeditions, but was also a significant collector of plant specimens, particularly on the latter expedition when F.M.Bailey was absent (Dowe & Broughton 2007, 2008). The co-collector of the type of *Garcinia mestonii* was Daniel Whelan, a Sergeant in the infamous [Queensland] Native Mounted Police (Richards 2008) and who led the force of troopers allocated as protection on the 1889 expedition. Whelan was honoured by Bailey with the Proteaceous tree *Lasjia whelanii* (originally as *Helicia whelanii* F.M.Bailey) and the fern *Blechnum whelanii* F.M.Bailey. The 'Whelanian Pools Camp' on Bellenden Ker was also named for him (Dowe & Broughton 2007).

Notes: *Garcinia mestonii* has been recorded as dioecious in the field; however, one plant cultivated by G & N Sankowsky at Tolga is distinctly monoecious with about 50% of flowers being male and 50% female. Individual branches on this tree appear to bear flowers of one sex only.

Etymology: The specific epithet honours Archibald Meston (1851–1924), a botanical collector, journalist, civil servant, explorer and member for Rosewood in the Queensland Legislative Assembly from 1878–1882.

8. *Garcinia mangostana L., *Sp. Pl.* 443 (1753). **Type:** 'Mangostan' in L.Garcin, *Philos. Trans.* 38: t. 1 (1734); *fide* Hammel (1993: 28).

Illustrations: Fleming (*c.* 1795–1805); Hooker (1855: t. 4847); van Nooten (1863); Marsden (2005: plate 3); Nazre (2006: 41, 45, 49, 52, 54, 57, 63, 181); Te-chato (2007: 248, 249, 250).

Tree to 20 m, agamospermous; exudate yellow; bark fissured and flaky; branchlets ± terete with some ribbing, glabrous. **Leaves** discolorous, coriaceous, glabrous, drying reddish-brown; petioles 10–30 mm long, not channelled on fresh specimens and slightly channelled on dried specimens, ligulate; lamina elliptic, broadly elliptic, ovate or oblanceolate, 100–250 mm long, 45–105 mm wide, base cuneate or obtuse; apex acute, shortly acuminate or obtuse; margin narrowly recurved; venation brochidodromous, primary vein distinctly raised on both sides; secondary veins 15–17 pairs, prominent, angle of divergence 50–70° from primary vein; 2 intramarginal veins, outermost 0.5–2 mm from margin, innermost 3–7 mm from margin; exudate-containing canals on underside as numerous branched lines running at angles between parallel to primary vein and margin, on upperside as numerous branched lines mostly running parallel to secondary venation. **Male flowers** unknown. **Female inflorescences** terminal, a solitary flower, pairs or rarely in 3's. **Female flowers:**

diameter 25–60 mm; pedicels 1.5–20 mm long; sepals, 4, 2-whorled, *c.* 20 m long, green, cream, yellowish, pinkish or reddish, cupular, coriaceous; petals 4, free, erect to spreading, broadly obovate or broadly orbicular, *c.* 25 mm long, cream, pink or reddish, glabrous, thickly fleshy; staminodes up to 20 shorter than ovary, adnate to petals, free, filament-like, *c.* 5 mm long, caducous; antherodes 1 per filament; ovary broadly ovoid or ellipsoid or globose, 12–16 mm, sessile, 4–8-locular, locules uniovulate; stigma mass sessile, domed, diameter 8–12 mm, 4–8-lobed. **Fruiting pedicel** with 4 green to reddish sepals persistent at base; **fruit** a dry berry with a thick corky-leathery pericarp *c.* 9 mm wide, globose or depressed globose, diameter 35–70 mm, purple to blackish, glabrous; sepals persistent; stigma persistent, 4–8-rayed; seeds 4–8, 15–25 mm, testa brown; aril thickly fleshy and white. *mangosteen, Queen of fruit.*

***Additional selected specimens (from 5 examined)*: Queensland.** Cook District: Cultivated, Stanton property, Intake Road, Redlynch, Cairns, Jul 2013, *Cooper 2222* (CNS); North Johnstone River, off the Cooroo Lands Road, W of Innisfail, Jul 2007, *Bean 26749* (BRI); Dunk Island, Aug 1963, *Scanlan AFO 2812* (CNS); Dunk Island, Aug 1964, *Scanlan AFO 3490* (CNS); Tully, Sep 1941, *Shearer s.n.* (CNS).

***Distribution and habitat*:** *Garcinia mangostana* is unknown in the wild but is likely to have originated on Peninsula Malaysia (Richards 1990b). In Australia it is cultivated in the tropical lowlands of Queensland, and a recent collection (*Bean 26749*), in the Innisfail area, confirms naturalisation within Queensland rainforest. Three old collections from Dunk Island and Tully also indicate possible naturalisation (**Map 3**).

***Phenology*:** Flowers and fruit have not been collected from naturalised plants; however, Peter Stanton and Allen Sheather have cultivated plants in the Cairns and Daintree areas and record flowers from September to March; fruit December to July.

***Notes*:** *Garcinia mangostana* is thought to be a hybrid of multiple origins (Richards 1990b). Within tropical Asia, Mangosteens have been widely cultivated over hundreds of years for their delicious arils and are referred to as the Queen of Fruit. Several authors including Richards (1990a), suggest that male flowers are probably always absent and the species is an obligate agamosperm, forming fruit without fertilisation.

***Etymology*:** The specific epithet is derived from Latinising the Malay name *manggis*.

9. Garcinia brassii C.T.White, *Proc. Roy. Soc. Queensland* 47: 52 (1936). **Type:** Australia: Queensland. Cook District: Thornton Peak, in low scrub at the summit, 14 March 1932, *L.J. Brass 2277* (holo: BRI).

***Illustrations*:** Christophel & Hyland (1993: 81); Cooper & Cooper (2004: 123); Hyland *et al.* (2010).

Tree to 18 m, dioecious; exudate yellow; bark with fine vertical fissures; branchlets square becoming terete, new twigs mostly red, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 5–12 mm long, shallowly channelled on younger growth and on dried specimens, ligulate; lamina obovate or elliptical, 25–125 mm long, 16–63 mm wide, base attenuate or cuneate; apex acute, obtuse or emarginate; margin recurved; venation brochidodromous, primary vein ± flush on upperside but may be raised near base on dry specimens; secondary veins raised on both sides, 12–35 pairs, angle of divergence from primary vein 65–80°, forming loops 0.3–1.2 mm (rarely 4 mm) from margin, intramarginal vein often hidden in the recurved margin; some tertiary veins or veins forking off secondary veins may be present, if so, most diminish and do not reach the intramarginal vein; rarely are reticulations of similar strength to secondary veins present and if they do they are few and near the margin; exudate-containing canals on underside as numerous parallel lines, branched, straight, wriggly or curled, running at angles radiating between primary vein and margin. **Male inflorescences** terminal, a panicle, 3–18-flowered, 19–28 mm long; peduncles 10–21 mm long; bracts obovate or elliptical, keeled, 5–7 mm long, 2–3 mm wide (these may expand into small leaves up to 55 mm long and 21 mm wide), caducous; bracteoles 2–2.5 mm long and *c.* 2 mm wide.

Male flowers: fragrant, diameter 15–28 mm; pedicels absent or up to 6 mm long; sepals 4, 2-whorled, dark red, glabrous, margin thin; outer pair joined, D-shaped or ovate-orbicular, convex, 4–6.5 mm long, 4–6.5 mm wide, coriaceous; inner pair free, orbicular or oblong-orbicular, convex, 7–8 mm long, 6–7 mm wide; petals 4, free, erect or spreading, imbricate, orbicular, convex, 9–14 mm long, 8–14 mm wide, waxy-coriaceous, cream, yellow, pink or reddish, unmarked or with dark red markings, glabrous, margin thin; androecium 4-phalangiate, glabrous; phalanges adnate to petals, obovate or elliptical at anthesis, 5–8 mm long, 5–6 mm wide; anthers several to numerous per phalange, sparsely to densely clustered over phalange, bilobed, *c.* 0.5 mm long and 0.5 mm wide; pistillode rudimentary, attenuate-conical, 1–3.5 mm long. **Female inflorescences** terminal, a solitary flower 10.5–12 mm long; peduncle 1.5–3 mm long; bracts at apex of peduncle triangular, keeled, 3–7 mm long, 2–3 mm wide, caducous; bracteoles 1.5–2 mm long and 2 mm wide. **Female flowers:** fragrant, diameter 13–18 mm; pedicels absent or up to 1.5–3.5 mm long; sepals 4, 2-whorled, coriaceous, green and mostly blushed dark-red towards apex, glabrous, margin thin; outer pair joined, oblong, convex, *c.* 5 mm long and 4 mm wide; inner pair free, broadly ovate or orbicular, convex, 6–8 mm long, 5–7 mm wide; petals 4, free, erect to spreading, orbicular, convex, 8–10 mm long, 8–10 mm wide, waxy-coriaceous, cream or yellowish, often with red markings and often ageing to entirely reddish, glabrous, margin thin; staminodal phalanges 4, erect, adnate to petals, strap-shaped with flabellate apex, *c.* 3.5 mm long and 4 mm wide, apically branched into 5–8 individual filaments *c.* 1 mm long; antherodes 1 or 2 per filament, 0.5– 0.7 mm long; gynoecium globose, 6–7.5 mm long, 4–5 mm wide, glabrous; ovary ovoid, 5–6 mm long, 4–5 mm wide, sessile, 4-locular, locules uniovulate; stigma mass sessile, domed, diameter 4.5–5.5 mm, cream becoming reddish with age or exposure. **Fruiting pedicels** 2–3.5 mm long, 4 sepals persistent at base, **fruit** a fleshy berry, depressed globular, 22–45 mm long, 27–50 mm wide, dark red to blackish, glabrous; stigma shallowly 3 or 4-lobed, diameter 5.5–6.5 mm; seeds 1–4, 12–22 mm long, 10–18 mm wide; testa brown, smooth; aril fleshy, dark red. **Fig. 2A, 3A–C.**

***Additional selected specimens (from 36 examined)*: Queensland.** Cook District: Near peak of walking track to Mt Sorrow, 3 km W of Cape Tribulation, Daintree NP, Sep 2009, *Worboys 825* (CNS); NPR 133, Daintree, summit of Mt Sorrow track, Dec 1998, *Ford 2147* (CNS); VCL Noah, Mt Hemmant, Oct 1975, *Hyland 8490* (CNS); Thornton Peak, Jul 2008, *Jago 7152, Ford & Keith* (BRI); Thornton Peak, Sep 1937, *Brass & White 280* (BRI, K[1]); Thornton Peak, in valley between N and S peaks near campsite on Hilda Creek, Sep 1984, *Clarkson 5588* (CNS); Pinnacle Rock Track, 4.5 km W of Karnak, Jun 1992, *Forster PIF10708, Sankowsky & Tucker* (CNS); Along track to Devils Thumb, Sep 1997, *Jago 4496* (BRI); Mt Misery, E of Mt Spurgeon, 15.7 km NE of Mt Carbine, Nov 1988, *Jessup GJM861, Guymer & McDonald* (BRI); Mossman Bluff *c.* 10 km W of Mossman, Dec 1998, *Fell 1683* (BRI); Near Schiller's hut, Mt Spurgeon, Sep 1972, *Webb 13438 & Tracey* (CNS & BRI); 27.3 km from Rex Highway on Mt Lewis Road, Nov 1990, *Holland 31 & Hind* (NSW); Mt Lewis Road S[South] Mary LA, Nov 1988, *Jessup GJM1526, Guymer & McDonald* (BRI); Mt Lewis FR, 28 km along Mt Lewis Road, Jan 2002, *Forster PIF28164, Booth & Jensen* (BRI); Mt Lewis, on track to Rhododendrons, Sep 2012, *Cooper 2163 & Ford* (CNS); *ditto*, Dec 2012, *Cooper 2207 & Ford* (CNS); Mt Lewis, CSIRO plot EP18, Sep 2012, *Cooper 2162, 2164 & Ford* (CNS).

***Distribution and habitat*:** *Garcinia brassii* is endemic to the Wet Tropics bioregion of north-east Queensland from Mt Sorrow to Mossman Bluff and west to the Mt Lewis –Mt Spurgeon areas (**Map 1**), at altitudes between 500–1300 m. It occurs in rainforest (simple notophyll vine forest, complex notophyll vine forest and simple microphyll vine-fern thicket) on granitic soils.

***Phenology*:** Flowers have been recorded in June, August to November; fruit has been recorded in December and January.

***Etymology*:** The specific epithet is in honour of botanist Leonard J. Brass (1900–1971), collector of the type specimen.

10. Garcinia gibbsiae S.Moore, *J. Bot.* 55: 302 (1917). **Type:** Australia: Queensland. Cook District: Bellenden Ker, forest on long ridge, March 1914, *L.S.Gibbs 6306* (holo: BM[1]; iso: K[1]).

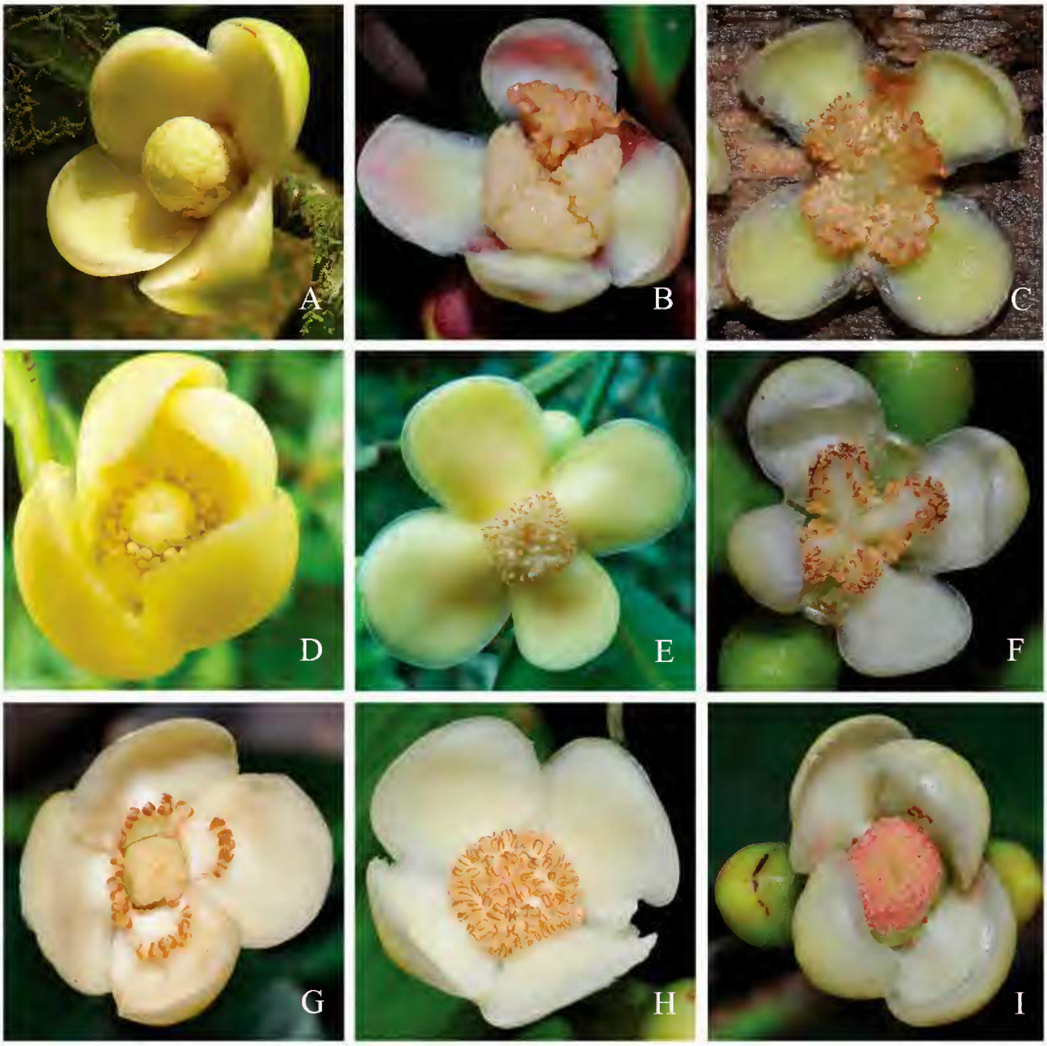


Fig. 3. Flowers. A. ***Garcinia brassii*** ♀, showing stigma and apically branched staminodal phalanges around the ovary (*Cooper 2163 & Ford* [CNS]). B. ***G. brassii*** ♂, showing 4-phalangiate androecium prior to anthesis (*Cooper 2164 & Ford* [CNS]). C. ***G. brassii*** ♂, showing 4-phalangiate androecium post anthesis (*Cooper 2164 & Ford* [CNS]). D. ***G. gibbsiae*** ♀, showing stigma and apically branched staminodal phalanges around ovary (*Cooper 2213 & Cooper* [CNS]). E. ***G. gibbsiae*** ♂, showing androecium of 4 fused phalanges (*Cooper 2212 & Cooper* [CNS]). F. ***G. warrenii*** ♂, showing anthers on 4-phalangiate androecium post anthesis (*Cooper 2158 & Hawkes* [CNS]). G. ***G. russellii*** ♀, showing stigma and apically branched staminodal phalanges around ovary (*Cooper 2150, Russell & Hawkes* [CNS]). H. ***G. russellii*** ♂, showing androecium of 4 fused phalanges (*Cooper 2149, Russell & Hawkes* [CNS]). I. ***G. warrenii*** ♀, showing stigma and apically branched staminodal phalanges around the ovary (*Cooper 2159 & Hawkes* [CNS]). Photos: A, D, E, *W.Cooper*; B, C, F, G, H, I, *T.Hawkes*.

Illustrations**:** Christophel & Hyland (1993: 81); Cooper & Cooper (1994: 288); Cooper & Cooper (2004: 123); Hyland *et al.* (2010).

Tree to 12 m, dioecious; exudate bright lime-yellow; bark with fine vertical fissures and irregular lenticels; branchlets shallowly ribbed, horizontal, erect or pendulous, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 8–20 mm long, channelled, ligulate; lamina oblong-elliptic, ovate, oblanceolate, elliptical or elliptic-obovate, 65–200 mm long, 30–93 mm wide, base cuneate or obtuse, apex acute or obtuse, margin thickened and sometimes remotely recurved; venation paxillate, primary vein raised on both sides; secondary veins numerous (more than 35), ± flush, parallel, angle of divergence with primary vein 70–90º, intramarginal vein on the margin; exudate-containing canals similar on both sides as sparse lines, branched or unbranched, mostly running at a slightly narrower angle than the secondary veins and sometimes crossing over them. **Male inflorescences** terminal or rarely axillary, a solitary flower, pairs, or a 2–8-flowered raceme, up to 38 mm long; peduncle 3–22 mm long; bracts narrowly triangular, convex, 5–10 mm long, 3–4 mm wide, glabrous; bracteoles triangular, convex, *c.* 2 mm long, glabrous. **Male flowers:** not fragrant, diameter 17–46 mm; pedicel absent or up to 2.7 mm long; sepals 4, 2-whorled, convex, may be slightly keeled, green, margin thin; outer pair joined, D-shaped, 5–8 mm long, 7–9 mm wide; inner pair free, orbicular, 5.5–7 mm long, 8–10.5 mm wide; petals 4 (rarely 3), free, orbicular, convex or flat, 11–20 mm long, 11–20 mm wide, thick, waxy, yellow (sometimes blushed with pink), glabrous, margins thin and mostly incurved; androecium of 4 fused phalanges creating a solitary receptacle, rhombic, adnate to petals, divided into 4 shallow lobes at apex, diameter 10–13 mm; anthers numerous, densely clustered over receptacle, subsessile, strap-shaped or wedge-shaped, bithecate, 0.9–1.3 mm long, 0.5–1 mm wide, glabrous; pistillode absent. **Female inflorescences** terminal, solitary or 2-flowered; peduncles 1–2.5 mm long; bracts triangular, keeled, 3–5 mm long, 1.5–2 mm wide, caducous; bracteoles triangular, orbicular or ovate, slightly keeled, *c.* 3 mm long and 2 mm wide, caducous. **Female flowers:** faintly fragrant, diameter 15–22 mm, pedicels 1.5– 2.5 mm long; sepals 4, convex, green, glabrous, margin entire and membranous; outer pair narrowly joined, D-shaped, 5–6.5 mm long, 8–10 mm wide; inner pair free, orbicular, 6.5–8 mm long, 7.5–12 mm wide; petals 4, free, orbicular, convex, 14–17 mm long, 11–15 mm wide, waxy-coriaceous, yellow, glabrous, margin thin; staminodal phalanges 4, free or adjacent pairs fused, adnate to petals, strap-shaped, erect, 2.5–5 mm long, 3–3.5 mm wide, apically branched into 6–9 individual filaments *c.* 1 mm long; antherodes 1 or 2 per filament, erect or introrse, oblate, *c.* 1 mm long and 0.6 mm wide; gynoecium urn-shaped, 7–9-locular, surface irregularly lobed, glabrous; ovary globular, 4–5 mm long, 5–6 mm wide, sessile, 7–9-locular, 1–4 ovules per locule; stigma sessile, domed, 7–9-rayed, diameter 5–6 mm. **Fruiting pedicel** 2–4 mm long, 4 sepals persistent at base; **fruit** a semi-dry berry, top-shaped, broadly-ovoid or truncated-globose, base truncated, apex acute, beaked or rarely truncated, 30–62 mm long, 30–67 mm wide, green, septal radii conspicuous as 7–9 shallow ribs or lines; stigma persistent at apex, 7–9-rayed; locules 7–9, septa thick, coriaceous and entire; seeds 1–4 per locule, ± globular, 10–18 mm long, 7–11 mm wide, testa brown, aril absent. *mountain mangosteen*. **Figs. 2E, 3D & E.**

Additional selected specimens (from 29 examined)**: Australia. Queensland.** Cook District: Mt Bellenden Ker, east slopes, April 1948, *Brass 18330* (BRI); Mt Bellenden Ker, *c.* 7/8 mile SE of the centre peak, June 1969, *Smith 14690* (BRI); Near junction of E and W Mulgrave River in SFR 310, Upper Goldsborough LA, 19.1 km SSE Little Mulgrave town, Nov 1988, *Jessup GJM1746, Guymer & McDonald* (BRI); Old Mailman's Track, W of Windin Creek, Feb 1995, *Hunter 849* (BRI); SFR 755, Gosschalk LA, EP/34, Nov 1976, *Unwin 117* (CNS); SFR 310, Windin LA, Apr 1973, *Hyland 6702* (CNS); Lamonds [Lamins] Hill, Atherton Tableland, Oct 1949, *Stephens NQ Nat. Club No. 13312* (BRI); SFR 310, Swipers LA, Oct 1963, *Hyland 278RFK* (CNS); Headwaters of Jimpee Creek, *s.dat.*, *Hunter 4522* (CNS); TR 1230, Boonjee LA, Oct 1979, *Moriarty 2678* (CNS); *ditto*, May 1982, *Gray 2550* (CNS); TR 1230, Boonjee LA, Boonjee, walking track to Stockwellia site, June 1992, *Tucker & Sankowsky s.n.* (BRI [AQ546523]); Wooroonooran NP, track to Chuck Lunga Creek, E of Boonjee, *Forster PIF19286 & Tucker* (BRI, CNS); Mt Bartle Frere, 1.8 km WSW Bobbin Bobbin Falls, 4.4 km

NNE Boonjee, Nov 1988, *Jessup GJM1049, Guymer & McDonald* (BRI); Boonjie LA near Bartle Frere track, 0.9 km SE of Bobbin Bobbin Falls, Nov 1988, *Jessup GJM269, Guymer & McDonald* (BRI); Westcott Road, Topaz, Jul 1992, *Cooper 320 & Cooper 320* (CNS); *ditto*, Mar 2013, *Cooper 2212, 2213 & Cooper* (CNS); Topaz, Dec 1970, *Kitchener s.n.* (CNS); Downey Creek SA 34, 24.6 km SE of Millaa Milla, Oct 1988, *Jessup GJM2217, Guymer & McDonald* (BRI).

***Distribution and habitat*:** *Garcinia gibbsiae* is endemic to the Wet Tropics bioregion of north-east Queensland where it occurs in rainforest (complex mesophyll vine forest and simple notophyll vine forest) on basalt soil from the eastern slopes of the Mt Bellenden Ker Range to Downey Creek near Innisfail and west to the Boonjie-Topaz area (**Map 4**), at altitudes between 120 and 1160 m.

***Phenology*:** Flowers have been recorded from February to June; fruit has been recorded from July to January.

***Affinities*:** *Garcinia gibbsiae* appears to be most similar to *G. russellii*. Both species have tough leathery leaves with numerous parallel secondary veins and green fruit with up to three or four seeds in each locule. *G. gibbsiae* is a moderately to densely branched shrub or small tree, with bright lime-yellow exudate, leaf bases which are either cuneate or obtuse and never peltate or cordate, male inflorescences solitary or a few-branched raceme and petals yellow, fruit with spacious locules not completely filled by seeds; locular septa thick, fleshy and entire. *G. russellii* is a slender and sparsely branched shrub or small slender tree with colourless, milky or white exudate, peltate leaves usually with cordate bases, male inflorescences a 9- or more-flowered panicle and petals cream or white, fruit with seeds tightly packed within each locule which mostly cause the exocarp to bulge; locular septa thin, pithy and incomplete.

***Etymology*:** The specific epithet honours British botanist Lilian Suzette Gibbs (1870–1925).

11. Garcinia russellii W.E.Cooper **sp. nov**. Similar to *Garcinia gibbsiae* but differs in the exudate colour (clear or slightly milky versus bright lime-yellow), leaves (peltate versus not peltate), male inflorescences (nine or more flowers versus up to 8-flowered but usually less); fruit septa (thin, pithy and incomplete versus thick, fleshy and entire). **Typus:** Australia: Queensland. Cook District: North of Mossman River, Daintree National Park, 9 July 2011, *W.Cooper 2137, R.Russell, R.Jensen & R.Jago* (holo: CNS [1 sheet + spirit]; iso: 3 sheets to be distributed to BRI, CANB, MO).

Garcinia sp. (Mossman); Cooper & Cooper (2004: 124).

***Illustrations*:** Cooper & Cooper (2004: 124) as *Garcinia* sp. (Mossman).

Shrub or small tree to 6 m, sparsely branched with branches mostly pendulous, dioecious; exudate opaque white, colourless or slightly milky; bark with a few horizontal raised rings at old interpetiolar scars, dotted with small pustules; branchlets slightly 4-sided on new growth and becoming terete on older growth, glabrous. **Leaves** discolorous, coriaceous, glabrous, peltate; petioles 10–25 mm long, attached on underside of lamina; lamina oblong or ovate-oblong, 110–295 mm long, 45–100 mm wide, base cordate or rounded, apex acute and often almost aristulate, margin entire and strongly recurved; venation paxillate, primary vein distinctly raised on both sides, green on upperside and yellow on underside; secondary veins *c.* 100, raised on both sides, angle of divergence from primary vein 70–90°, intramarginal vein on the margin; exudate-containing canals sparse on both sides as unbranched or branched lines, mostly running at a slightly narrower angle than the secondary veins and sometimes crossing over them. **Male inflorescences** terminal, a panicle, 9–39-flowered, 30–62 mm long; peduncle 5–11 mm long; bracts narrowly triangular, convex, 8–9 mm long, *c.* 2.5 mm wide, glabrous; bracteoles triangular, convex, 2–3 mm long, 1.5–2 mm wide. **Male flowers:** not fragrant, diameter 13–27.5 mm, pedicels 2.5–5 mm long; sepals 4, 2-whorled, orbicular, convex, may be slightly keeled; outer pair joined, with margin entire or irregularly lobed, 4–6 mm long, 7–8 m wide, green, glabrous; inner pair free, with margin recurved, entire or irregularly lobed, 4–8 mm long, 4–10 mm wide, pale green, glabrous; petals 4, free, orbicular or oblong-orbicular, convex, 8.5–15 mm long, 7.5–15 mm wide, white or cream on the inner surface and cream or pale yellow on the outer surface, glabrous; androecium of 4 fused phalanges creating a solitary receptacle, rhombic, adnate to petals and flower base, undivided or divided into 4 shallow lobes at apex, diameter 5.5–11 mm; anthers numerous, densely clustered, subsessile, strap-shaped or broadly wedge-shaped, bithecate, *c.* 2 mm long and 0.5 mm wide, glabrous; fungiform pistillode present in some flowers, *c.* 4.5 mm long, diameter at apex *c.* 2 mm. **Female inflorescences** terminal, a solitary flower (rarely pairs); bracteoles narrowly triangular, convex, *c.* 8.5 mm long and 2.5 mm wide at base, glabrous, caducous. **Females flowers:** not fragrant, diameter 16–25 mm; pedicel *c.* 2 mm long; sepals 4, free, D-shaped, base truncate, apex obtuse, cream; outer pair narrowly joined, *c.* 6.3 mm long and 7.2 mm wide; inner pair free, *c.* 8.3 mm long and 10 mm wide; petals 4, oblong-orbicular, convex, *c.* 13.5 mm long and 10.5 mm wide, cream; staminodal phalanges 4, adnate to petals, somewhat square, apex rounded, antherodes 5–8 per phalange, *c.* 1 mm diameter; gynoecium urn-shaped, *c.* 6 mm long; ovary ovoid or top-shaped, 6–8-locular; stigma domed, 6–8-rayed, diameter *c.* 3.5 mm; ovules 1–4 per locule. **Fruiting pedicels** *c.* 2 mm long; 4 sepals persistent at base; **fruit** a semi-dry berry, top-shaped or broadly ovoid, mostly beaked, beak up to 20 mm long, 6–8 shallow septum-lobes or septum-lines, 60–72 mm long, 50–58 mm wide, green, dull (shiny when unripe), stigma remnants 6–8-rayed, diameter 5–6 mm; locules 6–8; septa thin, transparent, pithy and incomplete; seeds 1–3 per locule, wedge-shaped, 20–22.5 mm long, 18–23 mm wide; testa cream to brown; aril cream and netted, not fleshy. **Fig. 3G & H, 4.**

***Additional selected specimens (from 12 examined)*:** **Queensland.** Cook District: Finlayvale, NW of Mossman, May 2012, *Hawkes s.n.* (CNS); Mossman Gorge NP on circuit track, Dec 1989, *Jessup GJD3330, Guymer & Dillewaard* (BRI); above the north bank of the Mossman River west of Mossman, Jan 2003, *Jago 6382, Russell & Darwin* (BRI); N of Mossman River in Daintree NP, Dec 2002, *Russell 11* (CNS); North of Mossman River, Daintree NP, Jul 2011, *Cooper 2138, Russell, Jensen & Jago* (CNS); *ditto*, May 2012, *Cooper 2149, 2150, 2151, Russell & Hawkes* (CNS); *ditto*, Nov 2012, *Cooper 2167, Russell, Ford & Sheather* (CNS); *ditto*, Dec 2012, *Cooper 2205, 2206, Russell & Sheather* (CNS).

***Distribution and habitat*:** *Garcinia russellii* is endemic to the Wet Tropics bioregion of north-east Queensland where it is currently known to occur in rainforest (evergreen mesophyll vine forest) on granitic soils in the Mossman Gorge section of Daintree NP and at Finlayvale near Mossman (**Map 4**) at altitudes between 150 and 300 m.

At the type locality *Garcinia russellii* grows as a slender understory tree in rainforest under a canopy of *Backhousia bancroftii* F.M.Bailey & F.Muell. ex F.M.Bailey, *Flindersia bourjotiana* F.Muell., *Lindsayomyrtus racemoides* (Greves) Craven, *Hicksbeachia pilosa* P.H.Weston & *Calamus caryotoides* A.Cunn. ex Mart.

***Phenology*:** Flowers have been recorded in May and July; fruits have been recorded in December.

***Notes*:** Male flowers within the same inflorescence can be inconsistent with some flowers having a fungiform pistillode and others not having any indication of a pistillode.

The exudate-containing canals within the leaves of this species are indistinguishable from *G. gibbsiae* (**Fig. 2E**).

***Affinities*:** *Garcinia russellii* appears to be most similar to *G. gibbsiae*. Both species have tough coriaceous leaves with numerous parallel secondary veins and green fruit with up to three or four seeds within each locule. *G. russellii* is a slender and sparsely branched small slender tree with colourless, milky or white exudate, peltate or almost peltate leaves with distinctly cordate bases, male inflorescences are a 9- or more-flowered panicle and petals cream or white, fruit with seeds tightly packed within each locule which mostly cause the exocarp to bulge; locular septa thin, pithy and incomplete. Whereas, *G. gibbsiae* is a moderately to densely branched small to medium-sized tree, bright lime-yellow exudate, leaf bases which are either cuneate or obtuse and never peltate or cordate, male inflorescences solitary or a few-branched raceme and petals yellow; fruit

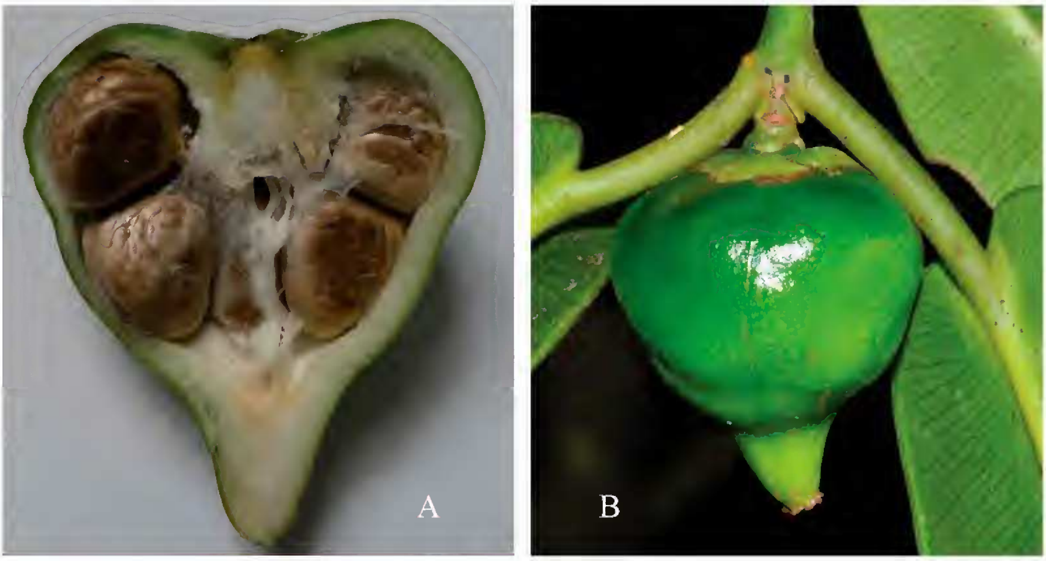


Fig. 4. ***Garcinia russellii*** fruit A. showing longitudinal cross-section and multi-carpelled locules, thin transparent septa and netted aril. B. showing beaked fruit, bracts and terminal attachment to branch (*Cooper 2206, Russell & Sheather* [CNS]). Photos: A, *W.Cooper*, B, *T.Hawkes*.

with seeds usually in spacious locules; locular septa thick, fleshy and entire.

***Etymology*:** The specific epithet is in honour of naturalist and conservationist Rupert Russell (1939–).

12. Garcinia warrenii F.Muell., *Vict. Nat.* 8: 109 (1891). **Type:** Australia: Queensland. Cook District: Coen River, in 1891, *S. Johnson s.n.* (holo: MEL *n.v.*; iso: BRI [AQ0340253[1]], K 000677819[1]).

Garcinia kajewskii C.T.White, *Contr. Arnold Arbor.* 4: 72 (1933). **Type:** Queensland. Cook District: Daintree River, 30 November 1929, *S.F.Kajewski 1418* (holo: BRI [AQ0340243[1]]; iso: S 11-34563[1]).

***Illustrations*:** Christophel & Hyland (1993: 82); Cooper & Cooper (1994:288); Hyland *et al.* (2003); Cooper & Cooper (2004: 123).

Tree to 25 m, dioecious; exudate yellow; dbh to 35 cm; bark tessellated and flakey in large trees, vertically fissured and with vertical lenticels; branchlets square or terete and mostly horizontal, glabrous. **Leaves** discolorous, coriaceous, glabrous; petioles 8–30 mm long, not channelled or becoming shallowly channelled in dry specimens, ligulate; lamina elliptic, oblong-elliptic, ovate, obovate, orbicular or oblanceolate, 40–230 mm long, 28–123 mm wide; base attenuate, cuneate or obtuse; apex acuminate, acute, obtuse, retuse or emarginate; margin not recurved or rarely slightly recurved; venation brochidodromous, often with a second set of loops near margin, primary vein on upperside raised towards base and more or less flush towards apex; secondary veins 24–50, angle of divergence from primary vein 60–90°, forming an intramarginal vein 0.5–4 mm from margin; exudate-containing canals difficult to see on fresh leaves, distinct on underside of dried leaves as numerous unbranched or branched straight or wriggly ± parallel lines, sometimes a second set of canals is visible as more widely spaced long straight lines running at angles 45–80° to primary vein and across the other canal set. **Male inflorescences** terminal or rarely axillary, a panicle, 8–66-flowered, 15–120 mm long; peduncle 5–38 mm long; bracts (which sometimes become full-sized leaves) at peduncle apex, triangular, becoming incurved, glabrous, 8.5–10 mm long, 2–3 mm wide, green with a yellowish primary vein, caducous; bracteoles triangular, incurved, 2.5–3 mm long, 2.5–3 mm wide, green, caducous. **Male flowers:** fragrant with a clove-like smell, diameter 10–15 mm; pedicels absent or up to 4 mm long; sepals 4, 2-whorled, outer pair joined, D-shaped, convex, 4–5 mm long, 4–5mm wide, green; petals 4, free, erect, imbricate, orbicular or oblong-obovate, may be convex, 5–7 mm long, 4.5–6 mm wide, cream or yellow, glabrous, margin usually recurved and thin; androecium 4-phalangiate; phalanges adnate to petals, obovate-elliptic at anthesis, *c.* 3 mm long, 2–2.5 mm wide; anthers several, most are clustered around phalange margin, bilobed, bithecate, *c.* 0.4 mm long and 0.2 mm wide, glabrous; pistillode rudimentary, attenuate-conical, *c.* 2.5 mm long. **Female inflorescences** terminal, a solitary flower or a 2 or 3(rarely 4)-flowered raceme, 17–25 mm long; peduncles 4–12 mm long; bracts at apex of peduncle triangular, keeled, 6–11 mm long, 3–5 mm wide, green with a yellowish primary vein, glabrous, caducous; bracteoles triangular, 3–4 mm long, 3–4 mm wide, green, caducous. **Female flowers:** fragrant with a clove-like smell, diameter 14–16 mm; pedicels absent or 3–5 mm long; sepals 4, 2-whorled, outer pair joined, inner pair free, D-shaped, convex, 5–6.5 mm long, 8–9 mm wide, green, glabrous, margin thin; petals 4, free, orbicular, convex, 9–11 mm long, 10–12 mm wide, cream or yellow, sometimes blushed with pink, glabrous, margin thin; staminodal phalanges 4, erect, adnate to petals, strap-shaped, *c.* 5 mm long and 3.5 mm wide, apex divided into 4–6 filaments with 1 or 2 antherodes on each side; filaments 1–1.5 mm long; antherodes obovate or rhomboid, *c.* 1 mm long; gynoecium oblong-globose, *c.* 8.5 mm long and 6–8 mm wide; ovary globose or 4-sided, 7–8 mm long and 6–8.5 mm wide, sessile, 4-locular, uniovulate; stigma mass sessile, domed, diameter 7–8 mm, cream becoming pink or reddish with age or exposure. **Fruiting pedicel** 3–5 mm long, 4 sepals persistent at base; **fruit** a fleshy berry, globular or depressed globular, often shortly beaked, 40–58 mm long, 50–75 mm wide, yellow or dark red to blackish; stigma shallowly 3 or 4-lobed or rayed, diameter 8–9.5 mm; seeds 1–4, 32–41 mm long, 23–35 mm wide; testa brown, smooth; aril fleshy, dark red, purple or cream. *native mangosteen, Warren's mangosteen.* **Fig. 2G, 3F & I.**

***Additional selected specimens (from 144 examined)*:** **Papua New Guinea.** WESTERN DISTRICT: Tarara, Wasi Kussa River, Dec 1936, *Brass 8430* (BRI). **Australia. Northern Territory.** Jessie River, Melville Island, Aug 2000, *Harwood 907* (CNS). **Queensland.** COOK DISTRICT: Gabba Island, Torres Strait, Mar 2003, *Waterhouse 6592* (BRI); Iama (Yam) Island, Torres Strait, Nov 2007, *Fell 8855 & Stanton* (BRI); Pajinka Lodge, Feb 2001, *Cooper 1453 & Jensen* (CNS); Escarpment of the Great Dividing Range, 18.2 km northeast of Heathlands Ranger Base, Heathlands D and O Reserve, Oct 1993, *Fell 3759, Stanton & Dibella* (BRI); Wattle Hills, Sep 2002, *Sankowsky 1836 & Sankowsky* (BRI); Stone Crossing, Wenlock River, Oct 1980, *Hyland 1075* (CNS); Hey Point, Aug 1985, *Gunness 1899* (BRI); Aurukun, banks of Watson River, Mar 2001, *Smith 4609* (BRI); Ling Creek Spring, Steve Irwin Wildlife Reserve, *c.* 16km due NE of Stone Crossing, Wenlock River, Sep 2009, *McDonald 2009-09-034 & Addicott* (BRI); 12.6 km WNW of Lockhart River Community, Mar 1994, *Fell 4194 & Stanton* (BRI); Nesbit River, Aug 1948, *Brass 19915* (BRI); Rocky River Crossing, Oct 1996, *Cooper 1011 & Cooper* (CNS); Gap Creek, *c.* 38 km S by E of Cooktown, Aug 1959, *Smith 10744* (BRI); Pilgrim Sands, Cape Tribulation, Jan 1993, *Cooper 474 & Cooper* (CNS); Clacherty Road, Julatten, Aug 2012, *Cooper 2158 & Hawkes* (CNS); Euluma Creek Road, Julatten, Aug 2012, *Cooper 2159 & Hawkes* (CNS); SFR 843, Parish of Bellenden Ker, Frenchman Creek, Sep 1986, *Gray 4333* (CNS); Babinda, Aug 2003, *Jago 119* (CNS).

***Distribution and habitat*:** *Garcinia warrenii* occurs in Australia and New Guinea. Within Australia it is recorded from north Queensland where it occurs in rainforest (complex mesophyll vine forest, mesophyll vine forest, complex notophyll vine forest, notophyll vine forest and simple microphyll vine-fern forest) and vine thickets on granitic, basaltic and rarely metamorphic soils from the Torres Strait islands to Babinda, altitude 0–1050 m. There are also two records from Melville Island, in the Northern Territory (**Map 5**).

***Phenology*:** Flowers have been recorded in July, August and September; fruit has been recorded in October, November, December, January and February.

***Etymology*:** The specific epithet is in honour of Dr William Henry Warren (1852–1926), Professor of Engineering at the University of Sydney.

Excluded Names

Garcinia cherryi F.M.Bailey, *Queensl. Fl.* 6: 103 (1902). Basionym of ***Ternstroemia cherryi*** (F.M.Bailey) Merr. ex J.F.Bailey & C.T.White (Theaceae).

Acknowledgements

Christina Zdenek, Brian Venables and John Pritchard are sincerely thanked for making several trips to check for flowers from the female tree of *Garcinia jensenii*. I am especially grateful to Rupert Russell for showing me *G. russellii* in the field, where he initially discovered them and for assisting on numerous trips across the Mossman River during varying water levels to finally collect enough fertile material for a formal description. Andrew Ford, Rigel Jensen and Jeanette Kemp have been invaluable in the field for their good company and sources of expertise. I also thank Frank Zich and Darren Crayn for support and access to the Australian Tropical Herbarium (CNS); Paul Forster for the complicated typification for *G. xanthochymus* and notes on the typification of *G. mestonii*, as well as other assistance; Ben Trupperbäumer for old German translations and Peter Bostock for translation of Latin descriptions as well as creating the maps. Bill Cooper, David Fell, Mark Harrington, Mel Harrison, Tim Hawkes, Bob Jago, Sarah Legge, Stephen McKenna, Steve Murphy, Garry Sankowsky, Allen Sheather, Peter Stanton & Gary Wilson are thanked for much appreciated assistance in various forms. Darren Crayn made valuable suggestions to an earlier manuscript. The curators of BRI, CANB, MEL & NSW are thanked for loans and/or photos of relevant material. Permits to collect were issued by the Queensland Department of Environment and Heritage Protection.

References

Anderson, T. (1874). Guttiferae. In J.D. Hooker, *Flora of British India* 1: 258–278. L.Reeve & Co.: London.

Bailey, F.M. (1889). *Report on new plants, preliminary to general report on botanical results on Meston's expedition to the Bellenden-Ker Range, by F.M. Bailey, F.L.S., Colonial Botanist*, p. 2. Department of Agriculture: Brisbane.

—— (1899). Guttiferae. In *The Queensland Flora*, Part 1, pp. 102–105. H.J.Diddams & Co: Brisbane.

—— (1902). *The Queensland Flora*, Part 6, p. 103. H.J.Diddams & Co: Brisbane.

CANBR (Centre for Australian National Biodiversity Research) (2010). *Australian Tropical Rain Forest Plants Edition 6* (online version), viewed 20 June 2012. http://www.anbg.gov.au/cpbr/cd-keys/rfk/index.html

Chah (2007). *Australian Plant Census*. http://www.anbg.gov.au/cgi-bin/apclist; Australian Plant Names Index, http://www.anbg.gov.au/cgi-bin/apni Accessed November 2011.

Christophel, D.C. & Hyland, B.P.M (1993). *Leaf Atlas of Australian Rain Forest Trees*. CSIRO Publishing: Melbourne.

Cooper, W. & Cooper, W.T. (1994). *Fruits of the Rain Forest*. Geo: Sydney.

—— (2004). *Fruits of the Australian Tropical Rainforest*. Nokomis Editions: Melbourne.

D'Arcy, W.G. (1980). Flora of Panama. Family 123. Guttiferae. *Annals of the Missouri Botanical Garden* 67: 969–1043.

De Candolle, A.P. (1824). Guttiferae. In *Prodromus Systematis Naturalis Regni Vegetabilis* 1: 557–564. Treuttel & Würtz: Paris.

Dowe, J.L. & Broughton, A.D. (2007). F.M.Bailey's ascent of Mt Bellenden-Ker in 1889, and notes on the publication priority of new vascular plant species from the Expedition. *Austrobaileya* 7: 555–566.

—— (2008). F.M.Bailey's taxonomy of A.Meston's collections from the Bellenden Ker Expedition of 1904. *Austrobaileya* 7: 677–679.

Fleming, (circa 1795–1805). Fleming Indian Drawings Collection circa 1795–1805, Natural History Museum, London/Science Photo Library http://www.sciencephoto.com/media/428689/enlarge Accessed July 2013

Hammel, B. (1993). In C.E. Jarvis, F.R. Barrie, D.M. Allan & J.L. Reveal. A list of Linnean generic names and their types. *Regnum Vegetabile* 127: 28.

Hooker, W.J. (1831). *Xanthochymus dulcis*. Sweet-fruited Xanthochymus. *Curtis's Botanical Magazine* 58: t. 3088.

—— (1855). *Garcinia mangostana*. Mangosteen, or Mangostan. *Curtis's Botanical Magazine* 81: t. 4847.

Hyland, B.P.M. (1982). *A revised card key to rainforest trees of North Queensland*. CSIRO: Melbourne.

Hyland, B.P.M., Whiffin, T., Christophel, D.C., Gray, B. & Elick, R.W. (2003). *Australian Tropical Rain Forest Plants. Trees, Shrubs and Vines.* CD–ROM. CSIRO Publishing: Melbourne.

Hyland, B.P.M., Whiffin, T., Zich, F. Edition 6. (2010). *Australian Tropical Rain Forest Plants,* CSIRO. http://www.anbg.gov.au/cpbr/cd-keys/rfk/index.html Accessed October 2011.

Jessup, L.W. (2007). Clusiaceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2007,* p. 54. Environmental Protection Agency, Brisbane.

—— (2010). Clusiaceae. In P.D. Bostock & A.E. Holland (eds.), *Census of the Queensland Flora 2010,* p. 44. Environmental Protection Agency: Brisbane.

Kirtikar, K.R. & Basu, B.D. (1918). *Indian Medicinal Plants*. Sudhinra Nathbasu: Bahadurganj.

Kostermans, A.J.G.H. (1980). Clusiaceae (Guttiferae). In M.D. Dassanayake (ed.), *Flora of Ceylon* 1: 72–110. Amerind Publishing Co. Pvt. Ltd.: New Delhi.

Maheshwari, J.K. (1964). Taxonomic studies on Indian Guttiferae III. The genus *Garcinia* L. *s.l. Bulletin of the Botanical Survey of India* 6: 107–135.

Marsden, W. (2005). *The History of Sumatra containing an Account of the Government, Laws, Customs and Manners of the Native Inhabitants.* ebook #16768 http://www.gutenberg.org/files/16768/16768-h/16768-h.htm#sumatra-03 Accessed July 2013.

Moore, S. (1917). A contribution to the phytogeography of Bellenden-Ker. II. Systematic account. *Journal of Botany* 55: 302–310.

Mueller, F.J.H. (1891). Descriptions of new Australian plants with occasional other annotations (continued). *The Victorian Naturalist* 8(7): 109.

Nazre, M. (2006). *Taxonomic Revision and Molecular Studies of* Garcinia *Section* Garcinia *(Guttiferae),* unpublished PhD thesis, The University of Edinburgh. Opara, L.U., Studman, C.J. & Banks, N.H. (1997). *Fruit Skin Splitting and Cracking.* In J. Janick (ed.), *Horticultural Reviews* 19(4): 227.

Richards, A.J. (1990a). Studies in *Garcinia*, dioecious tropical forest trees: agamospermy. *Botanical Journal of the Linnean Society* 103: 233–250.

—— (1990b). Studies in *Garcinia*, dioecious tropical forest trees: the origin of mangosteen. *Botanical Journal of the Linnean Society* 103: 301–308.

Richards, J. (2008). *The secret war: a true history of Queensland's Native Police*. University of Queensland Press: St Lucia.

Robson, N.K.B. (1960). Guttiferae. In A.W. Excell & H. Wild (eds.), *Flora Zambesiaca* 1(2): 378–404. Crown Agents for Overseas Governments & Administrations: London.

Roxburgh, W. (1805). *Plants of the Coast of Coromandel* 2: 51, t. 196. W. Bulmer and Co.: London.

—— (1820). *Plants of the Coast of Coromandel* 3: 66. W. Bulmer and Co.: London.

Sharma, B.P., Singh, T.D., Handique, P.J., Devi, H.S. (2012). Unambiguous identification of *Garcinia xanthochymus* (Clusiaceae) in Manipur, India. *Nebio* 3(3): 7–10.

Singh, N.P. (1993). Clusiaceae. In B.D. Sharma & M. Sanjappa (eds.), *Flora of India* 86–159. Botanical Survey of India: Calcutta.

Sompong, T. (2007). Floral and fruit morphology of some species in *Garcinia* spp. *Songklanakarin Journal of Science and Technology* 29: 245–252.

Stevens, P.F. (2007). Clusiaceae – Guttiferae. In K. Kubitzki (ed.), *The Families and Genera of Vascular Plants.* 9: 48–66. Springer-Verlag: Berlin/Heidelberg.

Sweeney, P.W. (2008). Phylogeny and floral diversity in the genus *Garcinia* (Clusiaceae) and relatives. *International Journal of Plant Sciences* 169:1288–1303.

—— (2010). Floral anatomy in *Garcinia nervosa* and *G. xanthochymus* (Clusiaceae): A first step toward understanding the nature of nectaries in *Garcinia. Bulletin of the Peabody Museum of Natural History* 51: 157–168.

Te-chato, S. (2007). Floral and fruit morphology of some species in *Garcinia* spp. *Songklanakarin Journal of Science Technology* 29: 245–252.

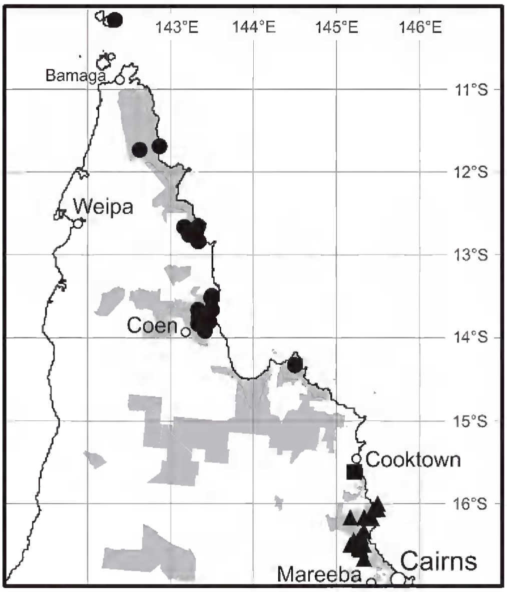
van Nooten, B.H. (1880). *Fleurs, fruits et feuillages choisis de l'ille de Java: peintes d'apres nature.* C.Muquardt: Bruxelles.

White, C.T. (1933). Ligneous plants collected for the Arnold Arboretum in north Queensland by S.F. Kajewski in 1929. *Contributions from the Arnold Arboretum of Harvard University* 4: 1–113.

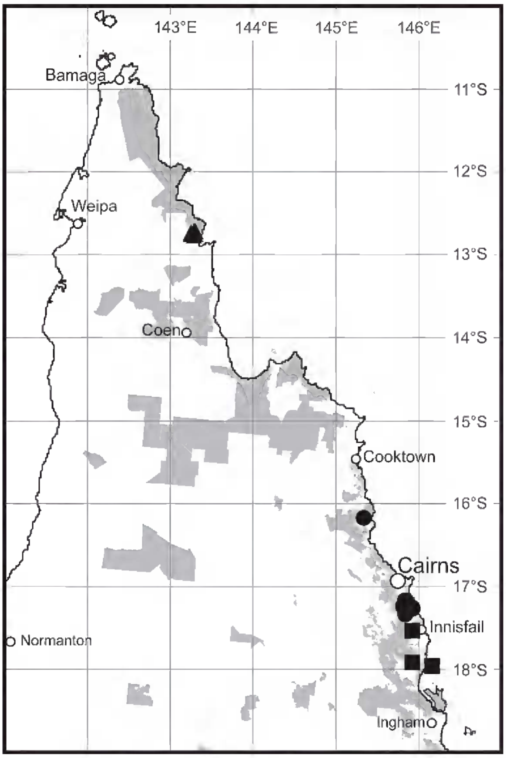
—— (1936). Contribution to the Queensland flora, No. 5. *Proceedings of the Royal Society of Queensland* 47: 51–84.

Wight, R. (1840). *Xanthochymus dulcis. Icones Plantarum Indiae Orientalis.* 1: t. 192. J.B.Pharoah: Madras.

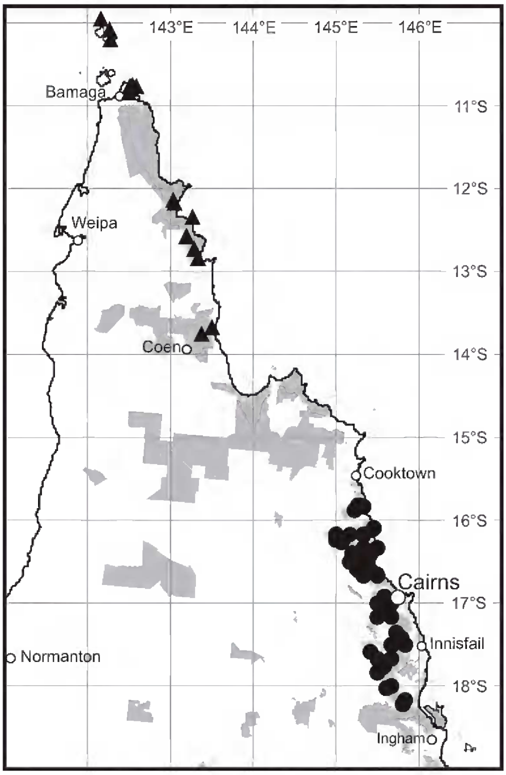
Zodiac Publications (undated). *Australian Tropical Plants version 4.1 DVD ROM.* Zodiac Publications.



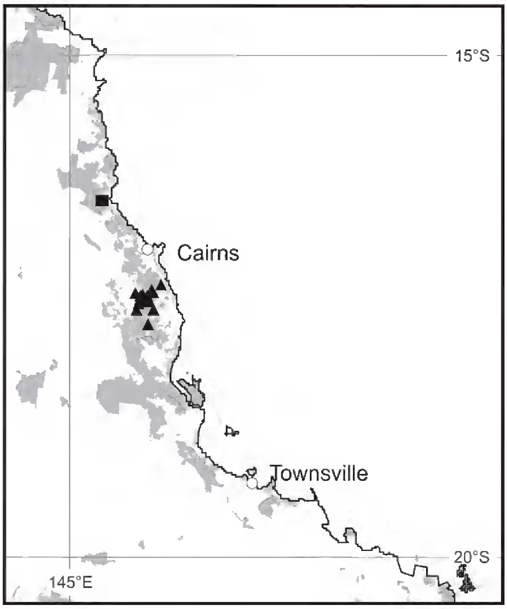
Map 1. Distribution of *Garcinia dulcis* ● (within Australia), *G. brassii* ▲ and **G. livingstonei* ■.



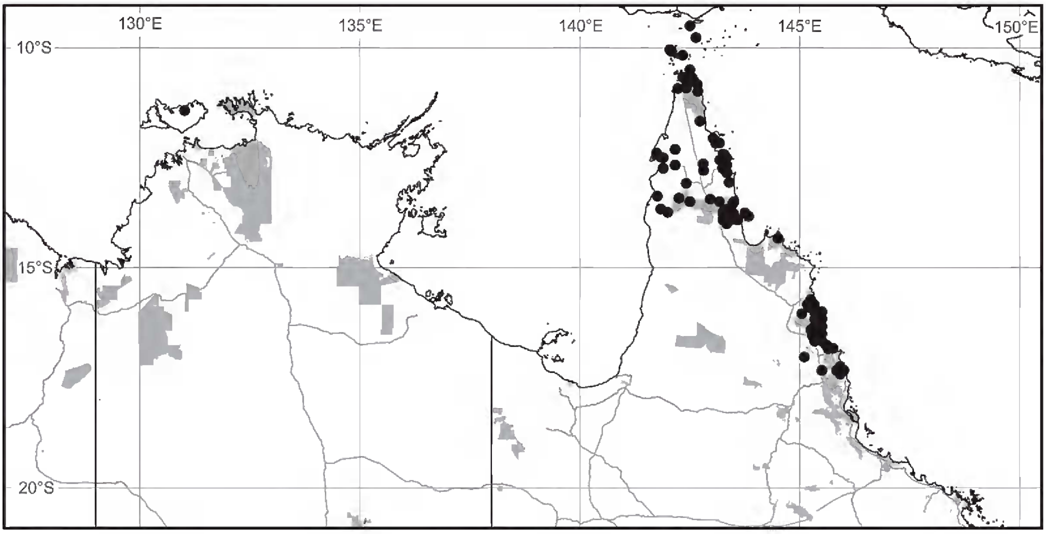
Map 3. Distribution of *Garcinia leggeae* ▲, *G. mestonii* ■ and **G. mangostana* ●.



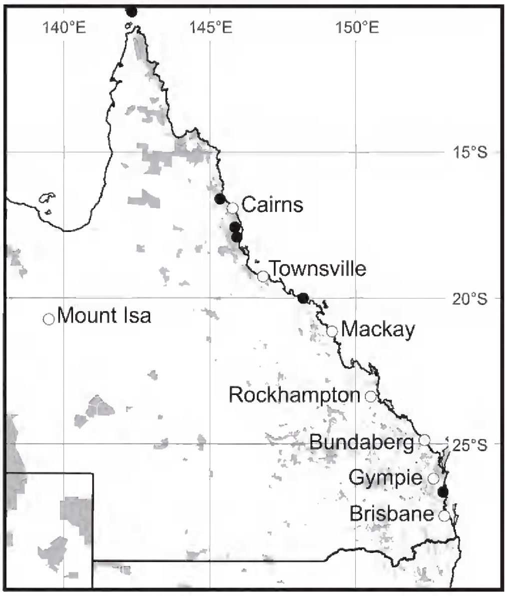
Map 2. Distribution of *Garcinia jensenii* ▲ and *G. zichii* ●.



Map 4. Distribution of *Garcinia gibbsiae* ▲ *and G. russellii* ■.



Map 5. Distribution of *Garcinia warrenii* ● (within Australia).



Map 6. Distribution of **Garcinia xanthochymus* ●.